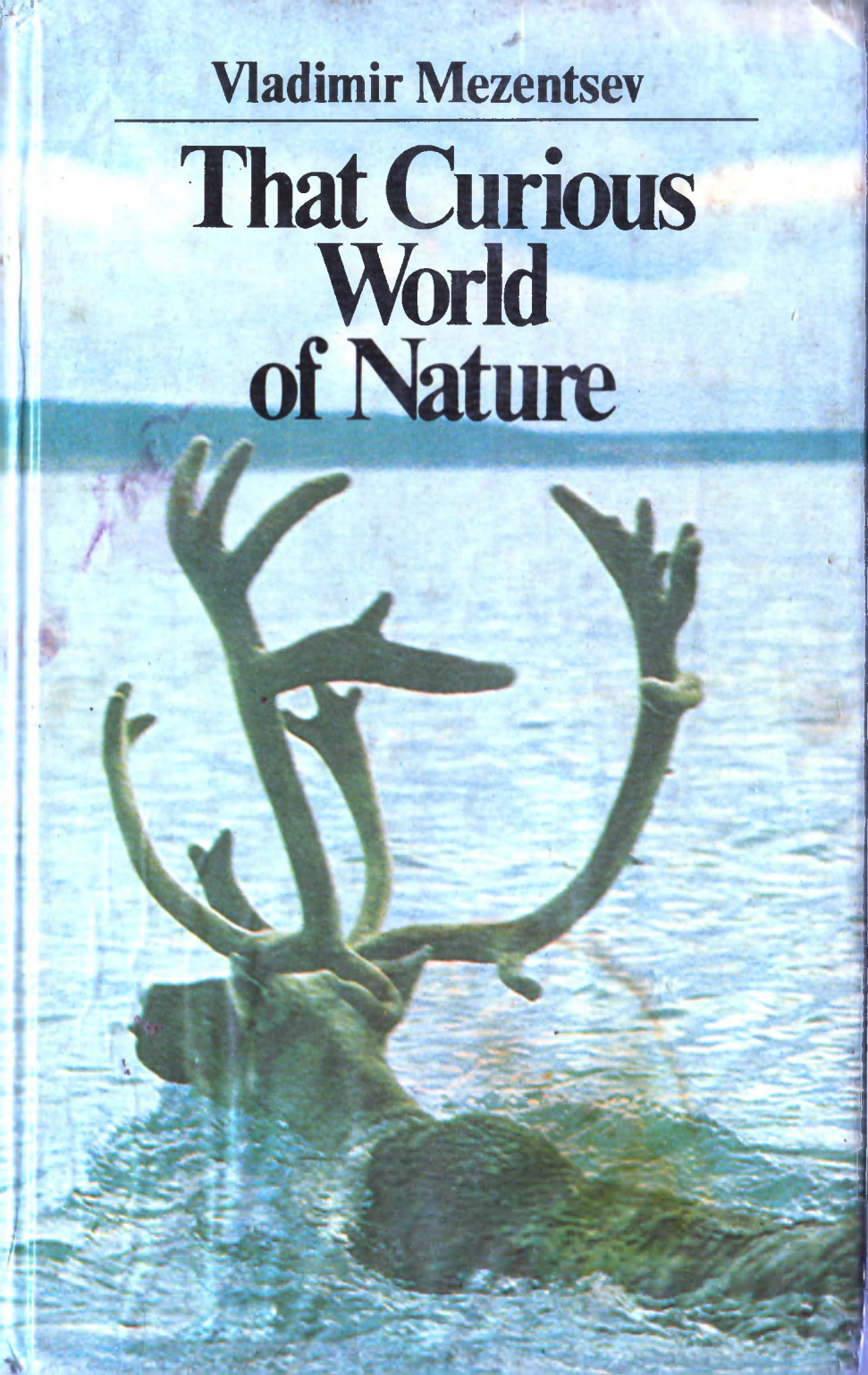
Vladimir Mezentsev

That Curious World of Nature



Vladimir Mezentsev

That Curious World of Nature

Geography
for Entertainment

Progress Publishers
Moscow

Translated from the Russian by *Sergei Chulaki*
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The author looks at some of the curious natural phenomena on our planet and takes us on a fascinating tour of glaciers, caves, mountains and deserts. He also tells us about the origin of lightning, the polar lights, mirages, volcanic eruptions, about deserts and permafrost areas, and how some of them have been opened up to habitation.

Владимир Мезенцев
УДИВИТЕЛЬНЫЙ МИР ПРИРОДЫ
Занимательная география СССР
На английском языке

© Progress Publishers 1987

Printed in the Union of Soviet Socialist Republics

М $\frac{1905010000\ 211}{014(01)\ 87}$ 77-87

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To the Reader

This book is about a country which is many thousands of miles from your home. It is a vast country: when the sun sets on the west of it, off the Baltic coast, a new day is breaking in the east, where the Pacific Ocean washes the shore. Some parts of this country know no real winter, with the hot sun shining all year round; in other parts the soil is bound by permafrost. This country is washed by twelve seas with a total coastline of about 47,000 km. There are about three million rivers in this country, and some of them, such as the Ob, Lena, Yenisei, which carry their waters to the Arctic Ocean, are among the biggest in the world. There are two and a half million big and small lakes on its territory, and among them Baikal, the deepest lake in the world. The highest mountains in this country, such as Mt. Communism, Mt. Victory and Mt. Lenin are well above the seven-kilometer mark.

The country we are talking about is the Union of Soviet Socialist Republics, the largest in the world. It would be impossible to tell all there is to tell about the Soviet Union in just a few books, much less in one. The book you are now holding in your hands will tell you only about some interesting and at times remarkable natural phenomena that occur in this country. To read it is the same as to make a trip, and even several trips, about the Soviet Union. Sometimes, to contrast or compare, the author describes some other parts of the globe outside the Soviet Union.

So, off we go!

THE FIRST TRIP

To the Far North

What does nature in this part of the globe look like? What changes does it go through at temperatures of 40 to 60° C below zero? How do people live where the soil has been gripped by icy cold for hundreds of thousands of years?

When Soviet cosmonauts first flew over our planet, they could see for themselves how much frozen water there was vast areas covered by snow and ice, which reflect sunshine.

In summer the white attire of the globe shrinks in size, and some of the snow accumulated in winter melts away. But high in the mountains and at the North and South poles, cold weather reigns supreme all year round.

This perennial ice covers an area of almost 16 million square kilometers, or one-tenth of the Earth's surface. Tremendous glaciers, called ice caps, cover the surface of the Antarctic and of many islands in the Arctic Ocean.

Huge tongues of ice descend from the highest peaks in the world the Hindu Kush, the Himalaya, and Tibet. Some glaciers are situated very close to the equator, on Mt. Kilimanjaro in the mountain chain of Ruwenzori in Africa, and on Orizaba and Popocatépetl volcanoes in México. These are mountain glaciers.

There are many ice-bound areas in the Soviet Union, too.

Floating Giants

THE NORTHERN BORDERS OF THE USSR ARE washed by the Arctic Ocean, which in this country is called the Cold Sea – a fitting name because in winter time most of its surface is covered with ice; the average thickness of the ice is about three meters. Huge ice floes are driven by the wind and ocean currents in different directions, sometimes over thousands of kilometers.

The islands in the Arctic Ocean are also covered with ice. For instance, ice covers more than 85 per cent of Franz Josef Land, and about half the surface of the Severnaya Zemlya Archipelago. This, however, does not mean that the ice stays stiff here all the time and does

not move. In many places the parts of the ice sheet slide into the sea, forming icebergs.

The word "iceberg", or mountain of ice, is a very apt term for this phenomenon. Some of them are dozens and even hundreds of kilometers long. Viewed from above, large icebergs sometimes look like islands, complete with contours of mountains and river beds. The ice surface is often covered with boulders, rock debris and even soil.

Some of these fascinating ice giants resemble now a medieval castle, now a sentry tower. These are designated as pyramidal icebergs. When sun rays fall upon them, the ice explodes into a riot of colours.

A graphic description of icebergs was given by the Soviet glaciologist I. Tsigelnitsky. "What colour is ice? Of course, you might say that ice is pale blue, green, white, or else completely transparent, like glass. I also thought so until I saw an iceberg floating in the sea – so big that it was almost unbelievable. Its top looks like a medieval castle decorated with numerous turrets with loopholes. And further down you can see semi-circular vaults scoured out by waves. Some of these vaults are open at both ends, overhung by glistening arrow-shaped icicles.

"Rocking lazily from side to side, the giant iceberg cuts the leaden waves, raising clouds of spray, while stormy petrels circle high above. The most remarkable thing is that its parts differ in colour. Its top is flaming gold and orange, and further down it has a streak of muted lemon and light green. At its visible base the iceberg is pitted with violet caverns. One of its sides looks dark brown, another is streaked like a zebra, and all drop sheer into the sea.

"However, as our ship approached the iceberg this colourful display gradually faded."

Pyramidal icebergs are born of glaciers that descend into the ocean from the mountains. It is fascinating to see a part of such a glacier overhanging the sea split off and fall into the water. Icebergs are born to a loud roar similar to an artillery salvo.

There are also flat icebergs which look like a snow-covered field. Such icebergs split off from coastal shelf glaciers that rise only a few dozen meters above sea level.

Soviet and Norwegian scientists estimate that about 7,500 icebergs are born in the eastern Arctic every year.

These drifting "vagabonds of the ocean" are the scourge of navigators. Even a modern ocean-going passenger liner is a mere toy compared with a huge iceberg. It is true, though, that navigators are now well equipped against a possible collision with an iceberg: modern navigation instruments, such as radars, enable the crew to "see" in any meteorological conditions. Before radar was introduced, however, many ships had fatal encounters with icebergs.

For many years, and even decades, the dangerous ice mountains wander about the seas and oceans. Gradually the wind and fog, waves and warm air erode the iceberg: it melts, loses much of its mass and then splits into smaller pieces. But the separate splinters, or ice floes weighing several tons and rounded by the sea water, are even more dangerous than bigger blocks of ice. Icebergs are clearly seen on the radar screen, while their fragments remain unnoticed and can therefore cause an accident.

It is true that encounters with the "vagabonds of the ocean" do not necessarily bring disaster. Once Soviet sailors spotted what they described as a "singing" iceberg. The sea water had scoured out holes down the entire thickness of ice, and these produced melodious sounds when the wind blew through them. Once an iceberg played a funny trick on some tourists on board a Canadian ship. When the ship came in sight of this iceberg the tourists asked the captain to come closer so they could photograph the iceberg which looked very picturesque. But just as the cameras started clicking, something unexpected happened: an invisible force began to lift the ship out of the water! In a few seconds the ship was lodged on a flat section

of the iceberg which until that moment had been hidden under the water.

As it turned out, this ice mountain rocked from side to side as it floated. When the ship approached, the iceberg had tilted towards her and soon thereafter began to lean over to the other side and trapped the ship. But that did not last long: the iceberg resumed its old position, the ship was afloat again.

Such icebergs are in the state of unstable equilibrium, and their geometric centre is close to their centre of gravity. Even a strong gust of wind or a big wave can send such an iceberg rocking evenly for a long time.

Ocean and People

THE "BREATH" OF THE ARCTIC OCEAN HAS A tremendous influence on the global climate. This is why it is so important to know more about this ocean, the condition of its ice and of the air masses over it. But the study of the natural processes taking place in the Arctic Ocean is often thwarted by the severe climate. The bitter frost, biting winds and long Arctic night, during which the sun does not rise over the horizon, for many months confronted the valiant explorers of the Arctic who dared to open its secrets and put down on the map the coastlines and islands of the "Cold Sea" (the name given to the Arctic Ocean by Russian seafarers in the old days). Many discoveries were made here at the cost of human life.

Only late in the 19th century, after Fridtjof Nansen's travels in the high latitudes, did it become known that the "Cold Sea" was an ocean. Long before Nansen's discoveries, however, the trappers and fishermen of the Russian North (the Pomors) went on long sea trips, discovering new lands and even making their homes there. For example, the Pomors discovered and settled the Spitsbergen Archipelago, which they called Grumant.

Over the past thirty years archeologists from many coun-

tries of Northern Europe have been carrying out research on Spitsbergen. Their findings testify to the fact that Russian Pomors lived there as far back as the mid-16th century. In 1981 archeologists working on West Spitsbergen Island uncovered the remnants of a house which contained sections of a big Pomor boat, fishing nets, household utensils, a wooden calendar and even a piece of a chess-board. All that shows that the dauntless Russian seafarers not only braved the harsh climate of the Far North, but in fact lived for many years on the islands they had discovered.*

Of course, the exploration and use of the Arctic were not limited to the study of the coastal regions and numerous islands. A major event was the discovery of the Northern Sea Route: it was found that it was possible to reach the Pacific Ocean by following the northern coastlines of Europe and then of Asia. It took Russian seafarers several centuries of persistent efforts to open up the new route. The first to reach the Pacific were the ships under the command of the Russian explorer Semyon Dezhnev in 1648. Today caravans of ocean-going vessels follow the Northern Sea Route, carrying cargo to Siberia and the Soviet Far East. The total length of this route, which links European and Far Eastern ports, is 5,600 kilometers (from the Kara Strait to Providence Bay). Of course, the climate of the Arctic is just as harsh and treacherous as it was in the old days, so that even now the navigation period here is not more than 2 to 4 months a year. In some sections of this great route, powerful atomic ice-breakers clear the way for caravans of ships.

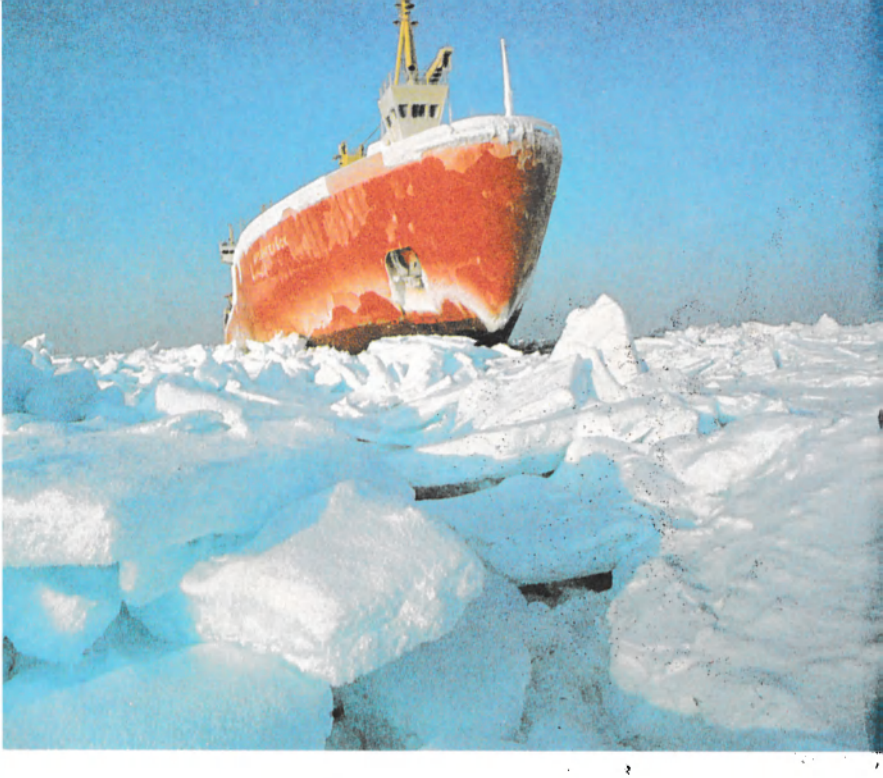
The adversities that Soviet seamen have to grapple with in the Arctic can well be illustrated by the following episode dating back to the summer of 1983. In that year the conditions in the East Siberian and the Chukotka seas,

* In 1925 the Spitsbergen Archipelago was officially included in the Norwegian sector of the Arctic.

The Northern Sea Route is an important shipping artery

from the estuary of the River Kolyma to the Bering Strait were extremely difficult. The many-year old ice floes, which had come here from central Arctic regions, blocked the sea route. Almost all Soviet ice-breakers were sent on a massive rescue operation. They cut open the solid sheet of ice, clearing a swath of water which, however, soon froze over. Floating ice posed no danger for the powerful atomic ice-breakers, but it threatened the safety of the cargo vessels with their lighter hulls. Thus the ice crushed through the hull of one such ship, and water began to flood the hold.

When an ice-breaker arrived at the scene of the disaster, many people had given up all hope for the stricken vessel. The water level in the hold was rising steadily, the stern



M/S Arkhangelsk in the Arctic Ocean

tipped up and the bow went down. But the sailors kept fighting to save the ship. Working waist-deep in the icy water, they set up pumps and sealed the holes with patch. The ship rocked on the waves; water and ice slush swirled about wildly in the hold, knocking people off their feet. The air temperature was minus 20°C. It was very cold, especially in a high wind. Whenever the rescue workers' hands touched metal they got stuck to it. Their fingers were numb, and their faces frostbitten. But the men did not give in! They fought and won out. The mangled ship finally arrived in Providence Bay.

Somewhere in the Arctic Ocean is the North Pole, which courageous people long sought to reach – by dog sled, on skis, and later by snowmobile and by plane. The first to

A North Pole drifting station

reach it by dog sled (in 1909) was the American polar explorer Robert Peary. Later Umberto Nobile, an Italian, made an unsuccessful attempt to get to the North Pole in a dirigible. In later years Soviet airmen flew over the North Pole many times. However, it was much later, in 1977, that people got through to the North Pole by ship. That ship was the Soviet atomic ice-breaker *Arctica*.

Many heroic pages in the chronicle of Arctic exploration were written by Soviet expeditions drifting on ice floes. Such expeditions have come to be known as SPs (from *Severny Polyus*, the North Pole). The first station was set up in 1937. Four Soviet scientists spent many months on a large drifting ice floe, studying weather

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and ice conditions in the high latitudes of the Arctic Ocean. Since then more than twenty-five SP drifting stations have been set up, each providing more and more information about the Arctic. In the spring of 1977, scientists at the drifting station SP-23 descended under the ice at the North Pole. Somewhat later the members of the same research expedition (SP-23), for the first time in the history of Arctic subglacial exploration, lowered an inflatable chamber of rubberised fabric through a hole cut in five meters of ice. The chamber contained people and instruments for the study of the ocean's submarine life.

The explorers saw wonderful, inimitable pictures under the thick ice. This is what V. D. Grishchenko of the Arctic and Antarctic Institute related about it:

"Every ice floe looks different under the water; no two ice floes are alike. The subglacial relief is extremely varied, sometimes resembling the profile of a camel, or a monster with a lion's mane and with a broad beard descending deep into the ocean... Once we found a bona fide cave – it was wide and quite high. Next time we went underwater we took a camp bed with us. The cave was so large that it had enough space for the camp bed, too..."

In emergency situations the explorers had to strike camp and move elsewhere. When the ice floe under the station developed a deep crack or split up, an emergency airlift to the mainland had to be organised.

Polar bears give explorers a lot of trouble. Once a family of polar bears visited the SP-23 station in a rather aggressive mood. They tore up a tent and an inflatable boat, plundered a crate of food and broke some research instruments.

Speaking about the heroic history of the exploration and use of the Arctic, mention should also be made of its geological history. As they studied fragments of ancient sedimentary rock lifted from the ocean, scientists came to

The camp of a high-latitude expedition

the conclusion that the Arctic was not always ice-bound, just as the ice cover did not always exist on Earth. Geologists believe that in its present state the Arctic Ocean has existed for about 40 to 50 million years. Some 65 to 80 million years ago, the Arctic Ocean was inhabited by warmth-loving organisms whose remains have been found on the ocean floor. Subsequently, the Earth's climate became colder, and ice caps developed at the North and South poles.

Why did the climate change so much? It is still hard to give a precise answer, and scientists have ventured different views on this point. The most likely explanation is that the inclination of the globe's axis changed. In other words, some 50 or 60 million years ago the North and South poles were not where they are now. When the inclination of the axis changed, the polar regions received less heat from the sun, and the planet began to "wear ice necklaces".

What is the future of the Arctic Ocean? Some scientists think that it might again become warm and ice-free, owing to the changing gas composition of the atmosphere. The point is that we live at a time when the concentration of carbon dioxide in the atmosphere is growing markedly. This happens primarily because more and more fossil fuel is being burned, and the carbon dioxide thus produced escapes into the atmosphere. The high concentration of carbonic acid in the air will, in the not too distant future, lead to the what is known as the greenhouse effect. In other words, the atmosphere with a high content of carbonic acid will absorb more heat radiated from the Earth's surface warmed by the sun. As a result, the air will be warmer and the ice cover of the Arctic and the Antarctic will melt away.

Such dramatic changes will metamorphose the Earth's climate. It is as yet impossible to predict in every particular what exactly these changes will be, but even now scientists are holding experiments with laboratory models of the Earth to find out what a global melting of the

perennial ice cover may lead to. It is possible that with the vast expanses of the Arctic Ocean ice-free, the atmosphere will become more humid and this, in turn, will produce more precipitation in Canada and India, in the Middle East and China. Conversely, the amount of precipitation in most of northern Europe and northern Asia, in the United States and over a considerable part of North Africa will sharply diminish, leading to the emergence of new arid regions.

"Ghost-Islands" of the Arctic

THERE ARE STILL MANY UNSOLVED RIDDLES connected with the Arctic Ocean, the "ghost-islands" being one of them. They are discovered and then they disappear, and neither sailors in earlier days nor air pilots today find anything there except water and ice.

Many stories about such islands are quite authentic. In 1707, C. Gillis, an English captain, spotted an island east of Spitsbergen. He could not reach it, but was sure that it was not an optical illusion. The "land" was set down on the map. About two hundred years later, at the end of the last century, the Russian ice-breaker *Yermak* set out for the North Pole with a research expedition headed by Admiral Makarov on board. The members of the exploration party also sighted "land" at the spot where Gillis had seen it. Wrote Makarov: "Everyone's joy aroused by the sighting of the land ahead was incredible. Any explorer would rejoice in making at least one small discovery... But was what we sighted real land? I think it was, but nobody would vouch for that. If they were clouds, they could not have stayed in one place for a full day and night."

Another three decades went by. In 1925, an English navigator again spotted the contours of an island in the same area. All the signs were that the land was real. Three years later, however, when the Soviet icebreaker *Krasin* visited this part of the Arctic, the sailors saw

no island. In 1930, the Soviet polar explorer Nikolai Zubov also came to the conclusion that there was no land there. Yet five years after that, none other than Zubov himself saw the "ghost-island" east of Spitsbergen.

Thus, reports about Gillis Land (also known as Giles Land) have come from a number of prominent Arctic explorers and travellers whom there was no reason to distrust. How could all these contradictory statements be reconciled? It was all the more necessary to resolve this riddle as by that time many more elusive "lands" had been spotted in the Arctic Ocean. For example, in 1934, the crew of the Soviet ship *Krestyanka* sighted land a short distance from Wrangel Island; some wintering Arctic researchers spotted the contours of a mountain north-east of Henrietta Island.

Many such "discoveries" have a simple explanation: the elusive "islands" in the ocean were actually large icebergs that had calved from glaciers. As it slips off land, the ice picks up boulders, pieces of rock, and detritus. Viewed from a distance, such an iceberg is very hard to tell from an island.

In shallow waters these would-be islands often run around and are then again picked up by a current and set adrift. Sometimes, the areas where they remained stationary for a long time are marked on the map as newly found land. For instance, one such ice "island", thirty kilometers long and about twenty-five kilometers wide, was discovered north of Wrangel Island in 1946. Its craggy "shores" rose several meters above the surrounding ice fields.

In the spring of 1969, another giant ice "island" was spotted in the north-eastern part of the Chukotka Sea. Incidentally, the ice island was the home base for the drifting research stations SP-18 and later SP-19.

With time, however, such ice islands melt, shrink in size and disappear. For example, the islands of Vasilyevsky and Semenovsky discovered off the coast of Yakutia in 1815

disappeared quite recently leaving behind vast shallow areas.*

The polar explorer V. Grishchenko describes how he once "undiscovered" a discovery made by Soviet Arctic pilots. In 1970 he was working at the SP-18 station. The pilots who were in contact with that station reported that they had discovered an unknown island in the ocean. The station chief and a group of divers set out for this island by plane, soon found it, but failed to make aerial photographs of it because of poor visibility. They did, however, spot some hummocks, elevations and boulders. When the aircraft landed on the ice, the island was found to be rather small: a hundred meters by fifty meters. "It was fringed with ice knolls. In its central part was a rock terrace. We saw some grayish-brown boulders, the larger ones at the bottom, the smaller on top. The exploratory party decided to sink a hole near the island in order to examine it from below. I went to the helicopter to put on my diving suit. The ice-hole was ready. I put on the flippers and went under the water.

"The ice there had a draught of three meters. I went further down but found no sign of ground. I went down ten meters more, then another ten. No solid ocean floor below, only water. The island must have had a steep bluff. I checked the compass and began to move towards the island. When I reached it my hands touched a solid wall that went sheer down. I slowly descended, always following its contours. The wall was pure ice: not a grain of sand in it. At a depth of fourteen meters the wall came to an end and I went under the ice. And again there was no sign of sand. Underneath I found nothing but water, no ocean floor. Wherever I went, a flat icy ceiling was overhead. The only conclusion that suggested itself was that this was a giant floating ice island with a draft of twenty meters, as distinct from ordinary ice floes sunk in water to a depth of three meters.

* Vasilyevsky and Semenovsky were not icebergs but actual islands consisting of frozen rock which was gradually eroded by water.

"We then carried out a routine examination of this ice floe. We measured the draft and the crevasse, and studied the surface of the 'island'. A more detailed analysis was carried out upon our return to Leningrad. The results showed that the ice floe had formed on the continental shelf off the craggy shores of Canada. The turbulent spring floods had brought pieces of rock from the nearby cliffs upon the ice. Possibly that same spring, the ice floe was picked up by the current from the sand bar and sent adrift on the usual long east-west route..."

It seems that the only correct, and long overdue, conclusion should be that all the discoveries of unknown islands in the Arctic Ocean are neither less nor more than a mirage, that all these "islands" are floating icebergs. However, not all Arctic explorers agree on this point. This is what Valentin Akkuratov, a veteran Arctic navigator, writes on this matter: "The Arctic water surface is more than thirteen million square kilometers. We polar pilots have flown its length and breadth many times. Our landings on drifting ice floes alone run into several thousand. It looks as if not even the smallest of islands could have remained unnoticed. However, if ever I were to be asked if there are any undiscovered islands in the Arctic, I would not hesitate a moment and say, 'Yes, there are!'" To support his statement, Akkuratov describes a flight he made with the pilot I. Cherevichny to the North Pole in August 1952, when they clearly saw in the Arctic Ocean some islands that had not been put down on any map.

"We were so flabbergasted by our discovery of land in this region that we thought at first that we had gone off course. Could it be that air currents had carried us all the way to the Canadian Arctic Islands? We checked our bearings by three radio direction finders, which confirmed that our estimated position was one where we expected to be. This, however, did not completely dispel our doubts, so we descended below the clouds and then checked our position by the elevation of the sun. Again, everything

tallied as planned: we were where we expected to be, and below us were two unknown islands clearly discernible against the background of oceanic ice.

"We had a strange feeling. Our eyes saw solid ground, rock streams, and flocks of murres and seagulls circling over the islands. But somehow we could not very well believe it possible."

Among the people on board that plane were A. Treshnikov, P. Gordiyenko and N. Volkov of the Arctic Institute who were convinced that the islands were real. Yet subsequently, when other Soviet airmen came to this area they found no islands there.

Could it be that the discovery made in 1952, like many previous ones, was that of some more "ice islands"? The seasoned polar explorer Akkuratov flatly denied it. The point is that in August 1952 the temperature at the North Pole was unseasonably warm – about 12°C above zero. Over his many years of flying in the Arctic he had never experienced such temperature. The snow cover at the pole was almost gone, thus exposing the unknown islands. A year later, when another group of explorers came to the same spot, the temperature was about zero, usual for August, visibility was very poor and the entire area was covered with snow.

Here is another fact in support of the theory that there are still more undiscovered lands in Arctic waters. In 1979 newspapers around the world carried a report that a group of Danish geodetic surveyors working at Greenland's northernmost cape discovered a previously unknown islet in the Arctic Ocean and actually set foot on its soil. The total area of the islet was a mere several hundred square meters. The surveyors found that the still unnamed island was the most northernly piece of land on this planet. The Danish party cleared the islet's surface of the snow and ice and exposed sand and rock. Concealed under perennial snow and ice, the islet was completely unnoticeable from a distance and was not marked on the map.

How Vize Island Was Discovered

THE HISTORY OF THIS REMARKABLE DISCOVERY began with a tragedy. In 1912, the Russian Naval officer Georgi Brusilov set out to do what many Russian navigators had dreamed of doing: to reach the Pacific Ocean by the Northern Sea Route. In August that year, the schooner *St. Anna* with Brusilov and his team of explorers on board put out to sea. A month and a half later the ship was locked in ice off the Yamal Peninsula and carried northward.

The drift lasted for the whole winter of 1912-1913, the following summer and then another winter. When there was no food left on the ship, it was then decided that navigator Valerian Albanov and ten men would make a trek over the ice in an attempt to reach land. All of the party died except two: Albanov and Conrad, a sailor. They were picked up by the ship of the Russian explorer of the Arctic, Georgi Sedov. Albanov had the log of the *St. Anna*, which he passed on to Vladimir Vize, a young scientist, who was a member of the Sedov expedition.

A few years later, after the October Revolution of 1917, work began on developing the Arctic. In the summer of 1918, Lenin signed a decree on the allocation of funds for an expedition to explore the Northern Sea Route. Vize, who at the time was a university professor, took part in this important effort. He concentrated on the study of the Kara Sea, known for its particularly difficult navigation conditions because of thick ice. It was necessary to find out how the ice was formed, where it was moving, and also to develop the best procedure and schedule for negotiating the northern route's "western gate", the Kara Sea. That was a difficult job: much too little was known about the weather, about the depth of the sea, about prevailing winds and sea currents which determined the movement of the ice floes. Vize recalled the drift of the Brusilov expedition and the *St. Anna* log. It was in the Kara Sea

that the *St. Anna* had been trapped in the ice and carried to areas where no ship had sailed before her. The log had some important entries about the weather, about depth soundings, and also contained day-by-day accounts of the drift.

Vize spent many months studying the *St. Anna* log. He established that at first the drifting schooner was driven by the winds and later carried north by a powerful sea current which the sailors knew nothing about. What struck him was the fact that at about 78-80° N the schooner kept moving in spite of both wind and current. This meant that the ice floes were driven by some other force. What could it be?

The conclusion Vize came to was bold and unexpected: the changing direction of the *St. Anna*'s drift was due to the existence of some unknown land in the northern part of the Kara Sea. "The ice that was driven by the wind encountered some obstacle, most likely by some land nearby," wrote Vize in a meteorological journal in 1924. Vize appended a map to his article in which he plotted a hitherto unknown island.

But this discovery made at the tip of a pen was yet to be verified. This was done six years later, in 1930, when a research expedition set out on board the ice-breaker *Georgi Sedov*, led by the celebrated Soviet polar explorer captain V. Voronin. One of the members of the expedition was Professor Vize.

After calling at Franz Josef Land and Novaya Zemlya, the *Georgi Sedov* headed for the island whose existence had been predicted by Vize. For more than three hundred kilometers the ship steered through the ice before it hit clear water. On the evening of August 13, 1930, Captain Voronin descended from the bridge into the wardroom and announced that he had sighted land ahead.

That was the island which was then named after Vladimir Vize.

The island was low and flat, with almost no vegetation. Its discovery was a remarkable demonstration of the effec-

Ice hummocks, a characteristic feature of the Arctic

tiveness of scientific prevision.

Fifty years previously, another similarly remarkable discovery was made in the Arctic Ocean: Franz Josef Land.

...In Issue Five, 1865, the *Morskoi Sbornik* journal carried an article, "Reflections on New Discoveries in the Arctic Ocean." The author of this article, N. Schilling of the Russian Navy, contended that lying between the Spitsbergen Archipelago and Novaya Zemlya was a piece of land which slowed down the ice drift in that part of the ocean. "It is very little likely that the Spitsbergen group of islands alone can keep unchanged the position of a tremendous mass of ice taking up several thousand square miles between Spitsbergen and Novaya Zemlya. Could it be that this circumstance and the relatively easy accessibility of the northern part of Spitsbergen are due to the existence between this archipelago and Novaya Zemlya of still another as yet undiscovered land which lies north of Spitsbergen and which holds up the pressing ice?"

Five years later the Russian Geographical Society decided to send an expedition to the northern seas. A member of the Society, Pyotr Kropotkin, was assigned to work out a detailed plan for the expedition. Kropotkin focused his attention on the enigma of the unknown land. He studied the movement of the ice in the area and came to the conclusion that Schilling was right in his predictions – there had to be land, very possibly a large island, between Novaya Zemlya and Spitsbergen, and the expedition had to find it.

However, while the government of the Russian Empire was still considering whether the exploration of the Arctic basin was worth the trouble, Austria dispatched a ship, the *Tegetthof*, to the Arctic Ocean in 1872. The sailors had a harsh welcome in the Arctic. That year the Barents Sea was wellnigh impassable. The thick ice locked the *Tegetthof* off Novaya Zemlya. For more than a year the ship drifted about the ocean, a mere toy of wind and current. The ice could crush the uncontrollable ship any time. The long Arctic night finally gave way to a short

Arctic summer; the situation did not change: the ship continued its northerly drift.

"Suddenly the fog dispersed on the north-west, and we saw the contours of some cliffs," wrote Julius von Payer, the leader of the Austrian expedition. "A few minutes later we saw a mountain country in full glory, its glaciers dazzling in the sun."

However, it was not until two months later that the members of the expedition disembarked. But even then they had to spend another long Arctic night before they started the actual exploration of the newly discovered land. Meanwhile, the *Tegetthof* remained in ice captivity. What was there to be done? In the spring of 1874, the participants in the expedition decided to abandon ship and to walk across the ice to Novaya Zemlya where they hoped to meet Russian trappers. The arduousness of this trek can be judged from the following fact: in fifty days after the Austrian explorers had left the *Tegetthof*, they had moved a mere 15 kilometers... Later the situation slightly improved: they encountered patches of clear water and then an area totally free from ice, where they could launch the life-boats. A month later the Austrians got to Novaya Zemlya where they were picked up by a Russian whaler. This is how another major archipelago, Franz Josef Land, was discovered in the Arctic Ocean.

Junior Brothers of Ice

PERENNIAL ICE HAS TWO JUNIOR BROTHERS, snow and hail.

Glaciers exist for thousands of years, whereas snow, i. e., atmospheric precipitation in the form of little crystals of ice coming down from clouds, in most cases lasts a mere several months during the cold winter season. In spring snow disappears. Sometimes snow lies on the ground for just a day or two, or even several hours, and then turns to water.

On the face of it, there is nothing enigmatic about this atmospheric phenomenon. The water accumulated in clouds freezes in cold air and then precipitates to the earth in the form of tiny crystals. Actually, there is more complexity to snow than meets the eye. Snow comes in an infinite number of patterns.

Suffice it to say that every snow-flake has a shape of its own, and there is an astonishing variety of them. Scientists have been studying these shapes for centuries, and have made more than five thousand photographs of them. Remarkably, no two flakes look alike. To this day nobody knows how many shapes a snow-flake can take. What has been established, though, is that there are two basic configurations: tabular hexagonal crystals and branched hexagonal crystals. It has also been established that when a snow-flake detaches itself from a cloud it sometimes changes its shape before reaching the Earth's surface. For example, a snow-flake can dry up and shrink on a dry day with sub-zero temperature. And, conversely, snow-flakes look large and fluffy in moist warmer air.

Why are snow-flakes so multifarious, and why is it that, in freezing, the water molecules assume now one shape, now another? So far, scientists have found no answer to this question.

The snow cover in the Baltic looks different from that in Siberia. Its density in Siberia is only half that in the western regions of the Soviet Union. In areas beyond the Arctic Circle the snow is sometimes so hard that it rings if struck with an axe. Strong winds pack its surface, and its top crust is so strong that it can stand up to the weight of a grown-up man.

In the Far North one can sometimes hear the "voice" of snow. This is how a member of an Arctic expedition describes this unusual phenomenon. He and other members of the expedition were in their tent when the radio operator ran in and announced that he had just heard somebody shouting for help. Who could that be? Everybody

was on hand; the nearest research station was some four hundred kilometers away. "The man must be hallucinating," was the first thought that crossed the mind of the leader of the group. Nevertheless, he got up and went out to see what was happening. He took a few steps and, to his surprise, heard a muffled voice crying out for help. Now he knew that the sound was produced by his own feet walking through the snow.

...On a calm day snowfall is harmless. But when it turns into a violent snowstorm, the situation becomes dangerous. This is what Sergei Aksakov, a well-known Russian writer, wrote about a snowstorm:

"A white cloud appeared in the east. It rose and grew rapidly, and when the last pale rays of the setting sun disappeared behind the mountain, the cloud grew rapidly, covering most of the sky and then burst into a blizzard. The white steppe began to heave in great stormy billows. Now the wind cried out like a little child, and now it howled like a hungry wolf...

"The white snow cloud, now as large as the sky itself, spread across the horizon, and the red glow of the evening sunset was blotted out from view. Then suddenly it was night. The snow-storm thrashed out with all its fury, the wind ploughing up the snow drifts and throwing them into the sky like so much fluffy down... Everything was one indiscriminate mass – ground, air, sky all turned into a whirlwind of stinging white dust that blinded, choked, roared, whistled, howled, groaned, tossed and lashed on all sides, from above and from below. Twisting and writhing like a snake, it strangled everything in its path."

Every year snow covers from 14 to 25 per cent of the Earth's surface. Luckily not more than that! Snow is the mirror of this planet, reflecting some 95 per cent of solar radiation. If the whole globe were to be covered with ice and snow, the annual mean temperature of the air on this planet would drop from 15° C above zero down to 85° C below zero.

Which are the snowiest places on the globe? One of them is at the Thompson Pass in Alaska, where the thickness of the snow cover reaches 15 meters – the height of a five-storey building.

In the USSR, the heaviest snowfalls (five to six meters) occur in mountain areas: the Krasnaya Polyana wild life preserve on the southern slope of the Greater Caucasus Range and the upper reaches of the Varzob River in Tajikistan.

And finally, a few words about the snow that can strike fear in superstitious people. Early in the last century, the crew of a small sailing ship saw such snow on the coast of the Arctic Ocean. It was still early spring, and the snow-clad coastline shone in brilliant sunshine. Suddenly the sailors saw a streak of bright red snow stretching several meters between coastal cliffs. The sight was so unusual that the crew was at a loss. Was it blood-covered snow?

The ship's captain dispatched a life-boat to the shore. When the sailors alighted, they found that the snow was covered with a thin bright-red film. Many of them thought that supernatural forces were at work here.

Actually there is nothing mysterious about this curious phenomenon, and scientists know its origin. There are red algae which consist of just one cell. These do not fear low temperatures and can easily propagate even in snow, and do it very fast – they can cover several square meters in just a few hours. Sometimes the wind picks the algae up and plants them in snow, and soon after a large bright red strip appears on its surface. The algae pose no danger to man.

Let us now turn to hail, a close relative of snow. Hail is atmospheric precipitation in the form of ice formations of different, mostly irregular shapes, their size ranging from a pea to a chicken egg, and sometimes even bigger. In summer, such precipitation comes from cumulonimbi, usually in rain-storms.

How and why does hail form in clouds? The upper part of a cumulonimbus, which is about six to eight kilometers above Earth, is bathed in cold air. The drops of water in that part of the cloud turn into tiny ice and snow crystals. On their descent, they pass through a mass of supercooled water drops which adhere to the crystals and freeze up. Also deposited on these crystals is water vapour, of which there is plenty in the cloud. The thicker the cloud, the greater the amount of vapour and water that adheres to the ice crystals, forming bigger hailstones. In strong gusty winds the hailstones do not reach the Earth's surface immediately but do a kind of dance in the wind, growing bigger and bigger as they fall.

Some hailstones registered weighed several hundred grams. In 1961, one such hailstone weighed 700 grams. In July 1968, hailstones as big as a goose-egg bombarded the town of Blagoveschensk in Siberia, turning the roof-tiles there into a mass of shards. That day local meteorologists found a hailstone weighing 560 grams.

In many countries special hail control teams keep under observation certain areas of dangerous cloud formation. When they spot a hail cloud, they locate the principal accumulation of hail with radars and then give battle to the elements by bombarding the dangerous cloud with missiles containing silver iodide, carbonic acid, and lead iodide. This is what happens afterwards. Little particles of these chemicals serve as the pellet nuclei, or embryos of hailstones. The bombardment usually lasts from two to five hours during which more and more artificial pellet nuclei are planted in the cloud. The nuclei attract supercooled water and vapour. The idea is that there are so many pellet nuclei that the hailstones thus generated are small, and therefore not dangerous to vegetation.

In the Soviet Union hail control teams protect orchards, vineyards and crops. Altogether about five million

hectares of farm land have been put under protection. Special radars probe clouds and target missiles which are fired into the danger zone, where they disperse artificial pellet nuclei. There is a special hail control centre in the USSR.

The Earth's Freezer

THE REALM OF ICE EXTENDS FAR BELOW THE earth's surface. Early in the 19th century, a merchant in the Siberian town of Yakutsk decided to sink a well in his courtyard. He hired workers who went on digging for days – but no water was in sight. The merchant had spent all the money he had hoped would be enough for making the well, and since no results were obtained, he decided to abandon the project. The well caught the eye of scientists who noticed that the ground remained frozen the entire depth of the pit.

How much longer would it be necessary to dig for water? None of the scientists knew that, and to answer this question they asked the workers to go on digging. Ten years had gone by and the well had developed into a deep shaft, but no matter how hard they tried they could not reach water – the ground was frozen solid. Finally the digging was halted at the depth of 116.4 meters. The astonishing result of the project was that even at that depth the ground was still frozen. This meant that in northern Siberia the ground remains permanently frozen throughout the year.

What does permafrost look like? In summer, the top soil is covered with green grass, trees and brush, but below the thin, sun-warmed layer lies permanently frozen ground pierced with thin veins of subsurface fossil ice. In some areas, permafrost comes very close to the surface; in other places its layer can be found dozens of meters deep.

Already the first studies of the Earth's natural freezer

brought some unexpected results. Large tree trunks, the remnants of primeval forests which grew here aeons ago, and even some fossil bones and whole bodies of extinct animals were found in Siberia and other permafrost areas. Permafrost has proved to be an excellent deep freezer which has been working for thousands of years, reliably preserving the bodies of some long extinct animals complete with flesh, skin and hair. On the Berezovka River in Yakutia, for example, scientists once extracted from the permafrost the carcass of a mammoth which had died thousands of years ago. The dead animal was found with a wisp of green grass in its mouth!

Upon examination of these finds scientists came to the conclusion that permafrost had not been there all the time. It was formed on Earth about a hundred thousand years ago during the Great Ice Age. Subsequently, the climate became warmer; the ice sheet moved to the islands in the Arctic Ocean, while on the mainland, under a thin layer of top soil which thaws out in summer, remained permanently frozen ground and large blocks of fossil ice which have been there to this day.

Scientists have studied the Earth's natural freezers sufficiently well and established that such refrigerators are by no means rare phenomena. In fact, permafrost areas take up one quarter of the land surface of the globe, and in the Soviet Union, almost half its territory. Solid tracts of permafrost stretch from the coast of the Arctic Ocean to the cities of Turukhansk and Yakutsk, and there are patches of permafrost further south, near Irkutsk, Krasnoyarsk, Chita and even along the Amur River.

It is true, though, that permafrost is not always the result of glaciation. In many places it appeared in areas with very low soil temperatures, where the ground gets so deeply frozen in winter that there is not enough time in summer for it to thaw out.

Surprisingly, permafrost was recently discovered in the Caucasus, where the climate is much warmer. A short

distance from Zheleznovodsk, a world-famous health resort, is a mountain called Razvalka, on the northern slope of which is a small area of northern vegetation stunted birch trees growing in a soil covered with moss and lichens, and an occasional bunch of cranberries and cloudberries. Even the air here is colder than that in the surrounding area, and blocks of ice have been found in the soil at the depth of seventy centimeters.

Examination of the subsoil areas showed the presence of permafrost. How it developed in these parts is a mystery, although various hypotheses have been advanced. The Mt. Razvalka area largely consists of igneous rock, or magma once ejected to the surface from the bowels of the Earth by a violent volcanic eruption. Such rocks are poor heat conductors. It is believed that when atmospheric water gets into crevices of the mountain it freezes up in winter but does not have enough time to thaw out in summer. This is how a natural freezer gradually formed underground. Another hypothesis claims that there is a large accumulation of carbonic acid inside the mountain. Gradually this carbonic acid evaporates and escapes through cracks in the mountain rock, cooling down the soil and freezing ground water. It has been established that the concentration of carbon dioxide in the permafrost area is higher than elsewhere.

Actually, the enigma of Mt. Razvalka is of purely theoretical significance. The situation is different in the north where the ground has stayed frozen for thousands of years. It manifests itself in many ways. Permafrost is treacherous! If, for example, you remove the grass and the moss from the top soil, the scar thus formed will eventually develop into a lake or a gully. Why does this happen? By removing the moss you also remove a good heat insulator, and the soil at this spot will absorb more heat in summer and cause the ground water to rise to the surface.

This alone would not be too bad. Yet sometimes the ground water in permafrost areas really acts up. In

harsh winters, some of the smaller rivers of Siberia freeze all the way down to the bottom, yet the springs continue to feed them with water. Where does the excess water go? It looks for alternate ways to get out. It can cut a new river bed under the layer of sand and pebbles, sometimes away from the main river bed; at other times it just bursts out to the surface. When this happens, one witnesses a rare spectacle indeed: the frozen soil explodes loudly, and a fountain begins to play.

Actually, it is not so bad when this underground stream is not very big. But what happens when such explosions are set off by big rivers? Imagine water gushing out of the ground in the dead of winter, in January, and flooding roads and settlements. Sometimes the disaster assumes such proportions that local factories cannot function normally and stop work. A flood at a temperature of 40° to 50° C below zero!

In summer, too, everything in these parts is different from what it is in the south. The river water level returns to normal after the spring floods, but in July or August the streams can swell up and burst the banks again. Local people call such floods "the black water". And almost black it is, for the streams carry liquid mud produced by the rapid thawing in the sun of the upper layers of permafrost. The thawing is so intensive that it results in another "spring" flood.

Builders have a particularly tough time doing construction work in permafrost. It is completely out of the question to build a house the usual way. While the construction work is going on, the ground under the house is as hard as rock. But later on, the temperature under the house becomes higher than that of the surrounding area, and the frozen soil begins to thaw, losing its strength. The house sags.

"When I lived in the country, our house stood on permafrost," recalls the Siberian writer G. Graubin. "Twice a year the walls of the house rose and sank by turns. In summer the wooden partitions pressed against the

ceiling and buckled, and in winter they did not reach the ceiling. The chimney now sank to the level of the roof, now stuck out above it. The cellar was sometimes filled with water which almost reached the floor."

Permafrost Put to Use

PEOPLE WHO MAKE THEIR HOME IN THE NORTH fight persistently with permafrost and look for effective new ways of dealing with it.

In Norilsk, a city beyond the Arctic Circle, modern multi-storey buildings are raised above the ground on piles, and do not have the usual foundation. The water supply lines in permafrost areas are sheathed in wooden casing and are also laid above the ground.

Another way of dealing with permafrost has also been tested: a patch of land to be used for a housing project was first defrosted and drained. In Vorkuta, another city beyond the Arctic Circle, a large administrative building was erected that way. Before the construction work began, the site was defrosted to a depth of a five-storey building, and two thousand tons of water were pumped out.

In 1984, the new Baikal-Amur railway, which is more than three thousand kilometers long, was put into operation. Many sections of the track are laid on permafrost. The railway line passes through numerous tunnels, and over two thousand railway bridges; there are hundreds of new settlements and towns along the route. It goes without saying that the builders and scientists have put in a great deal of effort to prevent permafrost from damaging this giant project.

An ingenious new method of housing construction, based on the use of metal refrigeration pipes, is now applied in the area. Each pipe has its lower end sealed and is then filled with kerosene. Then the opening at the top of the pipe is covered with a lid and the pipe

The city of Norilsk stands on permafrost north of the Arctic Circle

is driven into the frozen ground so that its upper section remains above the surface. The buildings rest on such pipes as they normally would on piles. And here the laws of nature get down to work. When cold weather sets in, the kerosene in the pipes begins to circulate, with the upper layers moving down, and the lower up. This happens because the kerosene in the upper section of the pipe, which is exposed to the cold air, cools down, becomes heavier and descends to the bottom section; there it transfers some of its cold to the soil and, after warming up a little, begins its ascent to the top again. The earth below is thus continuously exposed to cold temperatures and cools off more and more, in spite of the heat radiation coming from the house above it.

In summer the circulation of the kerosene in such thermopiles is stopped because the temperature underground is now lower than that on the surface. However, there is no danger that the ground under the building might thaw out, because each thermopile, over the winter months, will have frozen the ground solid some 10 to 12 meters around. Today new homes, shops and warehouses along the Baikal-Amur railway have been built on thermopiles. The new method has also been used in the construction of railway bridges and tunnels, with the simple "kerosene refrigerators" keeping the ground at the construction sites effectively frozen.

And how do the construction engineers in the Arctic cope with the task of excavating a foundation pit for a house? The method of "steam needling" is used, which requires a system of pipes with pointed ends and with numerous apertures in the sides. Fed into these pipes is compressed steam which thaws out the frozen ground and makes it soft so that concrete piles could be driven into it. There also are "flame drills" which pierce thick layers of frozen ground with a jet of superheated gas.

There is still another method used to drive permafrost deeper underground. In summer, a transparent plastic film is spread over the soil, which creates an artificial greenhouse effect, thawing out the frozen ground. Later, when autumn comes, the thawed-out soil is loosened up, so that in winter it will not freeze as much as it would otherwise. In spring the film is stretched over the same patch of land again. A few years later the permafrost recedes, and the thawed-out soil can be used for cultivating crops. This method has enabled Siberians to grow tomatoes, maize and apples in many permafrost areas in the north and east of the country.

One of the main attractions of Igarka, a big seaport in the lower reaches of the Yenisei in Siberia, is a geocryological research station where a shaft has been drilled deep into the permanently frozen ground. Going

down this shaft you can see blue veins of fossil ice in the grayish-brown layers of soil. And lower still is a veritable ice museum where plant and animal species are preserved in blocks.

Aurora Borealis

HAVE YOU EVER READ ABOUT THIS MAGNIficent polar phenomenon? One can say without exaggeration that there are very few natural phenomena that can rival the aurora in beauty and grandeur.

"...The sky was aflame. A great shimmering veil covered the entire sky, where some invisible force was causing its constant fluctuation. And it glowed with a delicate violet colour. First in one place and then in another appeared bright flashes that paled almost as soon as they were born, lasting a fleeting moment, like clouds spun of pure light... In several places what looked like violet clouds appeared and then disappeared. And then the entire aurora vanished. But immediately long pale-green shafts of light, which in some places collected in bunches of rays, shimmered up again. A sudden spurt ahead and they all skipped skyward like lightning. There they suddenly froze for another fleeting moment to form a tremendous ring. This then fluttered and trembled before disappearing just as suddenly as it had come forth."

This is a recorded impression of the aurora borealis given by the Soviet explorer of the Arctic, Georgi Ushakov.

These phenomena come in a great multitude of forms. The sky suddenly explodes into gigantic arches scintillating with green, orange, red and yellow. At night, arrow-like beams of light flare up and then disappear in rapid succession. At times, somewhere very high up appears an emerald-green "curtain" with a red fringe; it waves slowly as if held by some giant from a fairy-tale. The celestial light flashes like huge tongues of flame being

fanned by the wind. Very often such auroral luminosity takes up the better part of the sky and lasts for many hours; now fading, now flaring up with renewed force, the silent riot of colours continues.

When a group of explorers first came to Antarctica, they saw auroral lights near the South Pole, too.

The northern aurorae caught the imagination of Mikhail Lomonosov, a prominent Russian encyclopaedist of the 18th century. Deliberating on the forces that could excite the luminosity of air he hypothesised that the aurora borealis was of electrical origin. Most likely, he thought, those were electric charges in the upper, very rarefied layers of the atmosphere.

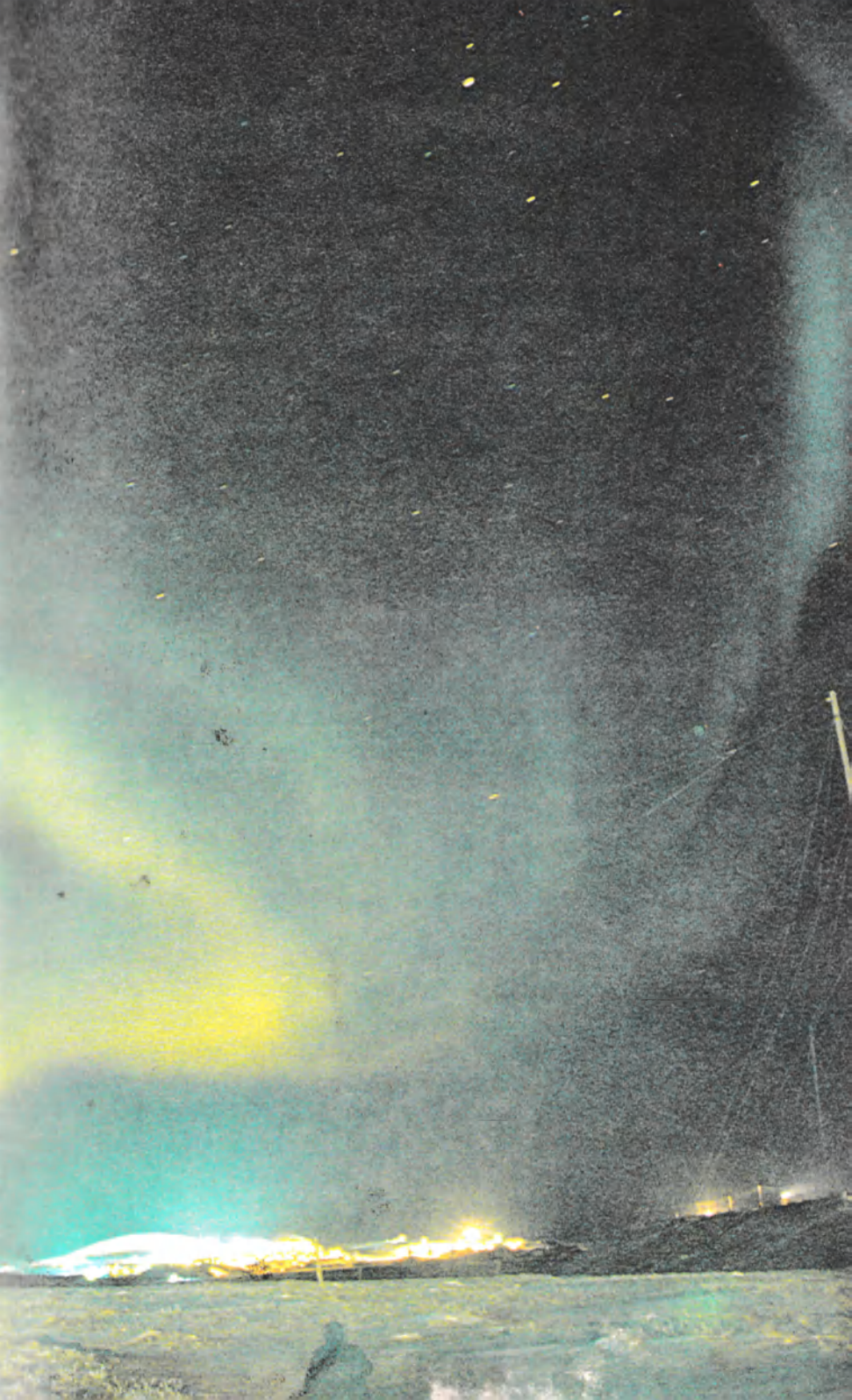
The scientist decided to put his guess to a test. He made a glass bowl, pumped the air out of it and then sent an electric discharge through it. The experiment bore out Lomonosov's hypothesis.

Subsequently the phenomenon of electric current passing through rarefied gases was studied by many scientists. They used glass tubes sealed at both ends. To put an electric current through such tubes, they sealed in small metal plates at both ends; the wires attached to these electrodes were connected to a power source.

While the gas inside the tube remained at normal atmospheric pressure, it did not conduct electricity, and there was no luminescence. But as soon as some of the gas was removed and the pressure in the tubes was thus reduced, particles charged with electricity (electric current) began to flow between the electrodes, and a glow appeared.

This luminosity was caused by the collision of fast-moving charged particles with the molecules of gas in the tubes. At first scientists experimented with nitrogen and hydrogen, later with argon and neon. It was found that various gases produced luminescence of different

Aurora borealis



colours: argon, for example, produced a bluish light, neon a red light. Thus what scientists had obtained in their laboratories was tiny aurorae.

The experiments with fluorescent tubes, however, did not disclose all the specific features of celestial lights. Why is it that aurorae occur only in the polar regions of the north and south? What particles or rays excite the air to luminosity high in the atmosphere, and at what altitudes? And finally, what explains the varied and constantly changing shapes of aurorae? All these questions had to be answered from a strictly scientific point of view.

It has long been known from observation that aurorae are particularly frequent and intensive in the years when the sun has the greatest number of spots (sunspots are the least hottest sections of the visible surface of the sun). Their number and their size vary from year to year. For instance, once every eleven years the number of sunspots reaches its peak and then gradually declines. After a while, they disappear altogether.

So the aurorae are closely linked to these phenomena which are remote from Earth. The undisputed fact is that whenever a large sunspot or a group of spots pass close to the centre of the solar disk, auroral lights begin to play in the sky some 20 to 40 hours later. This is accompanied by a magnetic storm on Earth, which sharply reduces short-wave radio communications, muddles the readings of the compass, and disrupts the operation of telegraph and telephone.

Why does all this happen?

The sun is an incandescent gas ball of tremendous size. This is a veritable stove that radiates vast amounts of heat into space. At the same time, the sun emits into outer space streams of electrically charged particles, protons and electrons. When these reach the upper, rarefied layers of the atmosphere the particles collide with the atoms and molecules of the atmosphere (primarily nitrogen and oxygen) and, in the words of phy-

sicists, excite them to action, when the atoms begin to give off light.

This is how aurorae originate. They occur at altitudes between eighty and one thousand kilometers and even more.

Why do we see the luminescence mostly at the North and South poles? The simple reason is that our planet is a huge natural magnet whose magnetic field can deflect streams of particles coming from the sun and direct them to the magnetic poles which are now close to the geographical poles of this planet.

And what about the interplay of celestial lights, the heaving folds of an auroral drapery, rays flaring up and waning by turn? These are closely linked with the changing force of the Earth's magnetic field and with the fact that the stream of particles coming from the sun varies in intensity.

When the sun ejects at great speed particularly powerful streams of particles, polar lights may not be so polar after all. In September 1957, for example, an aurora borealis was observed in Astrakhan, which is a very rare thing to occur. In 1941, polar lights were seen outside Voronezh. People say that their dazzling brilliance turned night into day.

Mirages

YOU MAY HAVE HEARD OR READ ABOUT THIS rather odd natural phenomenon, and some of you may even have seen this interplay of light in the atmosphere.

For example, a man standing on the seashore suddenly sees a huge ship flying over the waves: the ship looks as if it were far above the surface of the sea. Actually, this is a mirage, a reflection by air currents of a real ship sailing far away, beyond the horizon and, therefore, invisible.

Once the members of an expedition of the Swedish explorer Nils Adolf Erik Nordenskjöld had the following

curious experience. They saw a large polar bear near their campsite and rushed for their rifles. Just as one of them was about to pull the trigger, the phantom bear spread out its enormous wings and rose up in the air. As it flew, it grew visibly smaller and – to the surprise of the hunters – turned into an ordinary seagull.

Was that an optical illusion? Yes, it was, but not so phantomic as it looks at first sight. Such illusions can even be filmed.

Today scientists know the nature of this phenomenon. We are used to thinking that the propagation of light rays is always linear, but actually this is not so. Air is not homogeneous; it consists of layers having varying density, which makes linear propagation of light impossible. This is a law of optics.

Here is an example. A spoon dipped into a glass of tea looks as if it were broken in two. This illusion is due to the different densities of water and air. Passing from the less dense air into the denser water, the light rays change their rectilinear course, bending in the direction of the denser medium, which in this case is water.

But what happens when light passes only through the atmosphere? Every time when a ray of light passes from a layer of air of one density to that of another density, it changes its rectilinear course. You might have noticed that in summer all buildings and trees seem to shimmer and slightly tremble on the horizon. It is quite obvious that it is not the houses and not the trees that shimmer but their reflections. And this means, in turn, that the rays of light reflected by these objects and moving in the direction of our eyes continuously change direction. This pattern of movement of light in the atmosphere is called refraction.

Refraction makes celestial bodies seem to be located at a much higher angle of elevation than they actually are; for example, we still see the sun 5 to 10 minutes after it has disappeared beyond the horizon. Atmospheric

refraction is a very common phenomenon, so common that in most cases we just do not notice it.

However, such refraction may take other forms as well. Sometimes, light rays are reflected from certain layers of the atmosphere, as if the latter were a mirror, and sharply change direction. This may happen in summer when the sun heats up the air, especially its lower layers which thus become less dense. The rays of sun passing from some object downwards get reflected from such layers, as they would from a water surface, and then rise to a level where they can be easily observed. This is where we can see mirages or, to be more precise, lower mirages.

There are also other kinds of mirages when the "aerial mirror" reflects objects situated beyond the horizon. Early in the morning, when the lower layers of the atmosphere are still very cool from their contact with the surface of the Earth, the overlying layers are warmer, forming a reflecting layer of air, or an upper atmospheric mirror.

Upper mirages are most often observed at sea, and also in the polar latitudes where the lower layers of the atmosphere are usually colder than the upper ones. In the north, such phenomena occur mostly in spring, on days when a warm wind blows from the south, while the lower layers of the air remain cold from snow.

Upper mirages at sea send us reflections of ships and islands that are actually located far beyond the horizon.

There was a time when the legend about the Flying Dutchman, the ship of the dead, was common among sailors who believed that this ship was actually sailing the seas. Many of them claimed they had seen it with their own eyes. All their stories were very much alike: the Flying Dutchman suddenly appeared in front of their ships, silent and phantom-like, and sailed on without responding to signals, and then disappeared in the fog just as unexpectedly as it had come into view.

When scientists gave a simple explanation of the nature

of mirages, it became clear that the stories about the encounters with ghost ships were, in all likelihood, true. What sailors saw at sea were mirages, i.e. reflections of actually existing distant sailing vessels. Obviously, when the days of the sail were gone, the Flying Dutchman also vanished.

And what caused that transmogrification of a polar bear into a seagull? There is a perfectly logical explanation to this phenomenon as well. As a rule, mirages appear in windless weather, because winds can easily break the aerial mirror. Nature knows no total calm, of course, and yet from time to time the air condition is good enough for mirages to appear. This means that the aerial mirror is not so fragile after all, and that it does not fear slight fluctuations of the air. What happens, though, is that reflections of animals and objects are sometimes distorted almost beyond recognition.

In polar countries mirages sometimes assume most astonishing forms. A seafarer observed one such mirage in the Arctic Ocean. His ship was making its way among icebergs and huge ice floes, which sparkled and shone in brilliant sunshine. A slight breeze was rippling the water, and the air was very clear. Suddenly the horizon split in two and distant objects seemed to rise high in the air, changing their contours. The astounded sailors saw huge ice mountains, snow fields with ice hummocks, and a wavy shore line complete with hills. All these rose and sank again, shrank and expanded, giving the impression of rapidly changing patterns in a kaleidoscope. The objects that appeared over the horizon were most incredible: something looking like a tower, uncouth human forms, a sword; then suddenly all these figures turned into a giant mountain of ice which was reminiscent of a formidable mediaeval fortress. Trees, bears, dogs, birds and people all seemed to dance in the air. This fantastic picture vanished only at the end of the day with the rise of a strong wind.

Some mirages have caused serious disappointments. In 1906, on his trip across the Arctic Ocean Robert Peary saw a distant shore on the horizon, complete with a mountain ridge, which he could not reach. Nine years later it was established for a fact that the island "discovered" by Peary was nothing but a mirage of arctic ice.

At Zero Degrees Centigrade And Lower Temperatures

IN SPITE OF THE RUGGED CONDITIONS IN THE Arctic, the throb of life continues there throughout the year and goes far beyond small organisms. There are large animals there, too. The true master of the Arctic expanses is the polar bear. Protected from cold by a thick fur and fat, it can swim and dive deep underwater in any weather. The polar bear's white colouring conceals it amidst the ice. The bear wanders about the ice floes all year round in search of food – seals – and returns to the land only for breeding.

Another inhabitant of the Arctic Ocean is the walrus which feeds on fish and mollusks. Sometimes walruses hunt seal and even attack boats with people. The walrus has tusks which can reach 80 cm in length, and rough bristly whiskers on its muzzle.

This is what S. Uspensky, D. Sc. (Biology), a well-known Soviet polar explorer and an expert on the animal life of the Arctic, relates about walruses: "One day I witnessed a remarkable scene. It was a calm sunny day, and down below, just off the coast, I saw some large walruses popping up their heads in a patch of clear water. I thought they were feeding, so I rushed to the coast and lay down flat on the edge of an ice floe. In the crystal clear water, especially in the shadow cast by the ice floe, I could clearly see the animals moving some ten meters below.

The polar bear is the lord and master of the North

"The walruses were indeed feeding. I kept within sight two or three giants at a time. The animals seemed to be following a common pattern of movements. First they ventilated their lungs above water, then, after inhaling a fresh supply of air, they dived almost vertically to the bottom and proceeded to burrow around in the soil there. At times their tusks almost completely disappeared in the soil, their neck muscles moving vigorously whether they were swimming or remained motionless. When they ploughed up large chunks of ground, the water around them was all murky. After digging a furrow two or three meters long and sometimes even more, the walruses made some strange movements. They stretched out the front flippers and then, rubbing one

The polar bear lives and breeds in the ice country of the Arctic Ocean

flipper against the other, began a slow rise towards the surface. However, they did not come all the way, but instead dipped their flippers and again went down, quickly turning their necks and trying to catch something in the water.

"Trying hard to understand what they were doing I recalled that researchers had long been puzzled by the fact that the stomachs of slaughtered walruses were as a rule stuffed with the soft meat of mollusks which were at times so well preserved that the scientists could even determine what species these mollusks were. At the same time, no remnants of calciferous mollusk shells were found in the stomachs. The scientists wondered how the walrus managed in such a short time not only to collect a

fair amount of food under the water but also to clean it without damaging the tender parts of the mollusk body.

"Having spent about an hour on the ice, I finally understood how the walruses fed. First, they dug the mollusks out of the ground, gathering them up with their wide and flexible front flippers, not with their mouths. True, together with the mollusks, they also scooped up lots of silt from the bottom. When the walrus began its rise to the surface the first time, it rubbed the mollusks with its flippers, breaking the shells in the process. After that the walrus spread out its flippers and the pieces of shell dropped to the bottom. The meat took much more time to submerge so the walrus would catch it by taking another plunge before it reached the bottom. Only after it had collected all it wanted did the walrus come up to the surface. After that I began to understand why the inner surface of its flippers was so rough, like a grindstone or a grater. I also saw the function of the walrus' whiskers in feeding – they helped it to fish out the shelled mollusks in the murky water, especially during the polar night and in poor visibility."

There are many birds in the Arctic, especially in the islands of the Barents Sea. Nesting in the craggy cliffs are seagulls, auks, murres and eiders... These birds live in large colonies. The places of their habitation are always very noisy. At the slightest sign of danger, thousands of these birds rise into the air, screaming loudly.

Only the eider, a most valuable bird in the Arctic, keeps away from the colonies. The eider builds its nest with its own down which is literally worth its weight in gold. Man uses eiderdown for padding the clothes and sleeping bags of arctic explorers, mountain climbers, airmen and all those who have to live and work in severe cold.

These are all migratory birds. They come to the islands in the Arctic Ocean, where they hatch out their young, only for the summer.

A bird-colony

...It is no easy thing for warm-blooded animals to live in severe cold. Some animals are protected from it by their thick fur, others by a well-packed padding of down and feathers, and all by subcutaneous fat. Thanks to its long and thick fur, the northern husky, for example, can sleep in the snow even at 50° C below zero. Walruses and seals have a hairless skin, but the layer of subcutaneous fat in these animals is some 25 to 30 and more centimeters thick. This is why their health is not adversely affected when they stay in icy water for hours.

Significantly, the paws and flippers of arctic animals are always cold, having the same temperature as that of the environment. For example, the body temperature of

the white grouse is thirty-eight degrees higher than that of its feet. This is an important feature of survival in cold climate. After all, if the feet which come in contact with the snow were warm, the snow would melt and the bird would freeze to it in less than a minute.

What keeps the paws of polar animals from freezing and losing their mobility? Once again, they are protected by a layer of subcutaneous fat which, however, is different in chemical composition from the fat accumulated in other parts of the body and, most importantly, it freezes at a much lower temperature.

Travels to the Arctic

...THE ARCTIC REGION IS UNIQUE IN MANY respects. Several years ago some islands in the Arctic Ocean were made part of a new tourist itinerary. The trip begins at Murmansk and lasts twenty days. The first stop is Franz Josef Land, which is the most northerly piece of terra firma in Europe. Scientists based on these islands study the ocean, carry out observations of the aurora borealis, register streams of particles coming from outer space and run a weather service station.

From here the ship proceeds south-east to Dikson Island. Once, getting around the northern extremity of Novaya Zemlya was the dream of Arctic explorers. Not fortuitously was the northern end of Novaya Zemlya named the Cape of Desire. Today the cape is part of a tourist route.

Dikson Island, so named by the famous Swedish Arctic explorer Nordenskjöld in 1875, is now a major Arctic center. Situated at the crossroads of Arctic water and air routes, the island has become a sort of "postal capital" of the north-western part of the Arctic.

From Dikson Island the tourists go to Dudinka, a major sea and river port in the mouth of the Yenisei, and also the world's northernmost railway station. The railway

links Dudinka with Norilsk, a city built at the site of rich natural reserves of polymetallic ores.

From Dudinka the ship sails across the south-western part of the Kara Sea, through the Yugorski Shar Strait, out into the south-eastern sector of the Barents Sea, and then into the White Sea, with its famous Solovetskiye Islands. Over the past several years the islands have become an important tourist site with several hiking routes on the archipelago. Two days would be sufficient to take in the nature sights, visit the botanical gardens, and make a boating trip on the fresh-water island lakes linked by an old system of channels which make up a complex hydro-engineering system.

The next port of call is Arkhangelsk, a major sea and river port, which is also an important center of wood chemistry and the largest exporter of timber. Arkhangelsk is the home port of the Northern Sea Shipping Company, a river shipping company and of a number of fishing organisations. It is the gateway to the Arctic. In the past years more than 200 Arctic expeditions set out from there.

The final port of call on the itinerary is Murmansk.

THE SECOND TRIP

Siberia and the Soviet Far East

The Union of Soviet Socialist Republics lies in Europe and Asia, two parts of the world which are separated by the Ural Mountains. Stretching east of these mountains, over many thousands of kilometers, is a land which has since long ago been called Siberia. Today its population is over twenty million.

It is not easy to imagine how vast and varied is Siberia where plains alternate with mountains, and steppes and forest steppes merge into the tundra fringed by the taiga (coniferous forest). The scenery of these parts is extremely varied, because Siberia takes up an area as large as the whole of Europe and is much larger than the United States.

This is a land of contrasts: in winter the air temperature drops to minus 60°C, and in summer it rises to 40°C above zero. The pole of cold of the northern hemisphere is also in Siberia, whose other regions, thousands of miles away, are warm enough for grape to grow in natural conditions.

Siberia has the Soviet Union's mightiest river, the Yenisei, which rolls its waters in a northerly direction and cuts it into two roughly equal parts: West Siberia and East Siberia. "In my whole life I have never seen a river more beautiful than the Yenisei," noted the great Russian writer Chekhov after making a trip from Moscow to Sakhalin early in this century. Beyond the Arctic Circle, in the lower reaches of this river, is the large oceanic port of Igarka. In spite of the fact that Igarka is situated about 700 kilometers from the Arctic Ocean, it accommodates sea-going vessels.

Siberia's Lake Baikal, a unique "gem of clear water", is the deepest and the cleanest lake in the world. And further east is a fascinating land of mountains, volcanoes and islands, of wonderful and varied scenery (ranging from Arctic tundra to subtropics) extending over four and a half thousand kilometers. This is the Soviet Far East.

Unknown Land

SIBERIA... IN 1581, YERMAK AND HIS BAND OF Cossacks crossed the Stone Belt, as the Ural Mountains were known in those days, and entered an uncharted land. The Russian pioneer explorers intended to reach "the end of the world" where the sun rose and where, according to folk legend, some fantastic people, Samoyeds, lived by eating one another. These people were said to be almost dead in the long winter, and when the sun rose they came back to life; they traveled about the country on reindeer and on dogs. Some of them were said to have one arm, one leg and one eye.

However, not even the wildest rumors could deter the Russian explorers from going into new, uncharted lands, from seeing with their own eyes the astonishing creatures of the folk legends.

Yermak's trek began the settlement of Siberia by Russians. In the 17th and 18th centuries, many courageous explorers set out for Siberia. Driven by a desire to move further east and north to the shores of the Arctic and the Pacific, they crossed swamps, marshes and turbulent streams, and cut their way through the taiga.

In 1639, a band of Cossacks headed by Ivan Moskvitin, reached the Sea of Okhotsk and founded the first Russian settlement on its coast. Prior to this, the town of Yakutsk (now the administrative center of the Yakut Autonomous Soviet Socialist Republic) sprang up on the banks of the Lena River. More Siberian rivers, lakes, mountain ridges and settlements appeared on the map; sea coasts were also charted. This was like the discovery of a whole continent. In the second half of the 18th century the accounts that the pioneer explorers gave of their trips were used for making the first map of Siberia.

There are many geographical names on the map that speak about courageous Russian explorers: the Laptev Sea, Cape Cheliuskin, Krasheninnikov Island, the railway station of Yerofei Pavlovich, the city of Khabarovsk, etc.

In 1736, a ship called *Yakutsk* set out from the mouth of the Olenek River for the Cold Sea (the Arctic Ocean). The navigator was Semyon Cheliuskin; five years later he made a trek in a dog sled in bitterly cold weather to the northernmost point of Asia. Today this point bears his name Cape Cheliuskin.

The Laptev brothers, Khariton and Dmitry, were the first to plot on the map the coastline of the Taimyr Peninsula. Their name was given to the sea adjacent to this peninsula.

The first explorer of Kamchatka was Stepan Krasheninnikov. It took him almost four years to study its vast territory and to make a detailed description of the peninsula (more about it further in this account).

People who take their first train trip to the Pacific coast across Siberia are surprised at the unusual name of a railway station Yerofei Pavlovich. This was the given name of the Russian pioneer explorer Khabarov who started the economic development of East Siberia.

It is difficult to imagine how much perseverance and hard work, energy and courage the Russian people devoted to the exploration of Siberia. More and more brave men set out for the unknown lands. They penetrated deep into the Siberian wilderness and went further into the grim expanses of Far North, and never flinched in the face of any difficulties or challenges, and sometimes even in the face of death.

For a long time the vast Siberian land remained largely unexplored. By the second half of the 19th century, the town of Irkutsk had developed into a major population center, whereas next to it lay vast uncharted territories, one of which was the mountain country between two rivers, the Olekma and the Vitim, to the north-east of Lake Baikal. These mountains stood like sentries barring access to the north. A young scientist, geographer and geologist, Pyotr Kropotkin, decided to explore this part of Siberia, although he was not sure that he would be able to get across the formidable

The tundra in East Siberia

mountains. What decided him in favour of his venture was a map that he had come upon by chance. The map, which previously belonged to a local Tungus hunter was made from a piece of birch bark; it showed an itinerary through the forest to the very spot Kropotkin was planning to go. "This birch-bark map was so obviously authentic," he wrote, "that I entrusted myself to it and decided to follow the route drawn on it." The scientist discovered a large mountain plateau covered with a huge glacier, and several mountain ridges.

In Soviet times, the exploration of Siberia's "blank spots" continues in an organized manner and on a more massive scientific scale. What the brave pioneers of the early days could not do has become possible for task teams of scientists well equipped for work in hard-to-reach

areas. Some of the discoveries they have made are described below.

To the east of the Lena River in East Siberia, there is a vast mountain country larger than the Caucasus. Nothing was known about it until 1926. The maps of Siberia published prior to that year showed no mountains there. Only one scientist, Ivan Chersky, had visited this region late in the 19th century. Thirty-five years after that, a Soviet expedition headed by Sergei Obruchev, a young geologist, set out for the Kolyma area. "The vast region of more than one million square kilometers has only one known itinerary cutting across it, the route followed by Chersky. This region, which is twice as large as Germany, with numerous mountain ridges and mighty rivers, has to this day been as mysterious as the upper reaches of the Congo and the Antarctic mainland!" wrote Obruchev. The explorers discovered "huge snow-clad mountains at least two thousand meters high". The newly discovered mountain range was then named after its first explorer, Chersky.

Twenty years later, other groups of explorers discovered still bigger mountains covered with perennial snow some 300 kilometers south of the Chersky Range. "Although we were expecting to find some high mountains in the upper reaches [of the River Kolyma – *Tr.*], what we finally did see surpassed our highest expectations. The redoubtable mountain range, which stood out in bold relief, and its snow-clad peaks were so unexpected a sight that we remained dumbfounded for many hours, unable to tear our eyes away from this enchanting panorama," recalled geographer L. Bergman, one of the members of the expedition.

In our days East Siberia has changed beyond recognition. Where merely a few decades ago the first small groups of explorers made their way through the unknown wilderness and plotted the position of the mountains and rivers on their maps, now lies the Baikal-Amur railway and new towns and settlements have sprung up.

West Siberia

WEST SIBERIA TAKES UP THE ENTIRE AREA between the Urals and the River Yenisei. In the north it is bounded by the Arctic Ocean, and in the south it merges into the rolling plains of Kazakhstan as far as the Mongolian People's Republic. Almost the whole of West Siberia lies in the basin of two giant rivers - the Ob and its tributary, the Irtysh. Most of this vast region is taken up by the West Siberian Plain, one of the largest in the world. On the south this plain is fringed by the Altai mountains with Mt. Belukha rising four and a half kilometers above sea level.

The vast expanses of West Siberia are covered with thick impassable primarily coniferous forests, the taiga, which merges into forest steppes in the south. In the north it is dominated by the tundra with its stunted brush growing amidst moss and lichen around numerous lakes and swamps. Even where there is no open water the soil is very moist, because underlying the moss and lichen is permafrost which prevents water from sinking to any appreciable depth. The vegetation in the tundra is mostly low-growing creepers. After a short summer, the tundra is plunged into the darkness of the long polar night.

But here, too, in spite of the harsh natural conditions, live people, the small nations of the Soviet North: the Nentsi, Khanti, Mansi, Dolgans. Archeologists' finds indicate that man made his home in the north a long time ago. Today the intensive economic development of West Siberia has drawn many thousands of people of other nationalities from different parts of the Soviet Union. Over the past several decades rich oil deposits and gas fields have been discovered in these parts, and from here the valuable fuel is transported to Europe.

On the bank of the Yenisei there is a nature preserve of rare beauty, called Stolby (pillars). It comprises a chain of fantastically shaped cliffs. Each one of these cliffs has a name - Old Man, Feathers, Lion's Gate, etc. Alto-

gether there are more than fifty such cliffs in this area, which has been put under the protection of the state.

"The cliffs are huge and wonderfully shaped," wrote Prokhor Seleznev, a Siberian explorer. "It is not easy to get there, though either on horseback or on foot. And there are many wild animals there, too. Right are those who say that nowhere else can such things be found. And nobody can climb these cliffs; nobody knows what it is like up there."

Now thousands of climbers go up these cliffs every year. At the end of the last century, this nature preserve area on the Yenisei was the historic venue of clandestine rallies of the revolutionary youth of Krasnoyarsk. At one such rally a worker suggested that slogans be written on the cliffs. Soon, the word "Socialism" in red paint could be clearly seen high above on one of the giant pillars. Then the words "Will Come" were written at another spot. These were followed by "Workers" on another cliff, and by "Freedom". The governor of Krasnoyarsk, enraged, ordered his gendarmes to erase the revolutionary slogans. They found a guide who knew the way to the pillars but was not at all eager to help. When they finally reached a ledge and stopped for a rest, the guide disappeared. Afraid to move an inch, the agents just sat there until a whole day later, hungry and cold, they were finally helped down by local hunters.

The mute cliffs have witnessed many changes taking place in the area: first, there was the wilderness that struck pioneer explorers with its forbidding beauty, then it was the venue of revolutionary meetings, and finally it became a nature preserve in a country of victorious socialism.

Lake Baikal

IN A SONG WELL KNOWN IN RUSSIA, BAIKAL is called "a glorious sea". Anyone who comes to the

Lake Baikal

shores of this unique vast lake cannot help recalling these words.

There are two and a half million lakes in the Soviet Union. Most of them are in the north-western part of the USSR, an area called lake country. There are thousands of lakes there, ranging from tiny reservoirs to such giants as Lake Onega and Lake Ladoga, the largest lake in those parts. The total area of Lake Ladoga is almost 18,000 square kilometers. The tundra is also a country of lakes: hundreds of thousands of them are scattered over the infinite expanses of the north. In winter almost all of them freeze down to the bottom. In the southern part of Siberia there are many salt-water lakes used for the commercial production of common salt. The Caspian Sea is also a large salt-water lake

since it has no links with the World Ocean. However, because of its size (about 370,000 sq km) it is designated on all geographical maps as a sea. There is another such "sea" in Kazakhstan, a republic of the USSR. This is the Aral Sea which it would also be more correct to call a lake, or a sea-lake, if you will.

There are also some lakes in the USSR with a specific feature which makes them different. One such lake is on Kildin Island in the Barents Sea. This lake has been put under the protection of the state, and for an interesting reason.

The shores of the lake are bleak – not a blade of grass, no shrubs, just bare rocks. The lake is often hidden from view by fog. And its name is not very inspiring either: Lake Mogilnoye, from the Russian word "mogila", grave. Surprisingly, this lake, which is only seventeen meters deep, has five tiers of water.

The upper tier is fresh water. But if you go down you will encounter something very peculiar. At a depth of six meters the fresh water gives way to slightly brackish water, and further down, to salty sea water. And right next to the bottom is a tier of water saturated with hydrogen sulfate formed here from the putrefaction of plants and animals. The water between the hydrogen sulfate tier and the tier of sea water, which comes third from the bottom, is dark red because of the bacteria which are not affected by the hydrogen sulfate. Further up live the species that are common in fresh- and sea-water habitats – in the third tier, sea algae, actinias and starfish, and in the fourth, jelly-fish and other sea species used to slightly salty water. The "upper level" is home to fresh-water species.

This certainly is a strange lake, its origins going back to the time when the area that is now Kildin Island was covered by the sea. At present the salt-water lake is separated from the sea by a small sand bank through the lower layers of which sea water seeps in at high tide. Thus the lower layers of the heavy salty water get

constantly renewed by an influx of water from the sea, whereas fresh water from rain and melting snow runs off into the lake from above. As fresh water is lighter than sea water, it remains in the upper layer, and the two do not mix.

Some lakes are of unusual colours. In the Altai, for instance, there is a lake called Malinovoye (crimson) because of the numerous small red crustaceans living in it. In the southern Urals is a lake whose water is almost black, hence its name Chernoye (black). The colour of its water is affected by its proximity to deposits of nickel. In Kamchatka some lakes have a greenish hue; these have good living conditions for bluish-green algae. A lake on the Kurile island of Kunashir has milky-white water because it contains sulphur and hydrochloric acids, (more about Kamchatka and the Kurile Islands below).

As a rule, lakes live for a long time, and it is often next to impossible to find out how and when they originated. On the other hand, some lakes emerge suddenly as the result of geological catastrophes. In 1911, for example, an earthquake created a dam on the Murgab River in the Pamirs. The level of the Murgab rose, and several years later a huge lake about half a kilometer deep was formed.

The beautiful Lake Amtkel in the Caucasus was formed in 1891 when the river of the same name was blocked, in the deep gorge where it flowed, by a massive landslide that created a barrier over 150 meters high. At first the new lake had no outlet of any sort, but gradually the water scoured out a passage under the obstruction, and the river resumed its old course, except that part of it was still occupied by the lake.

There are many wonderful lakes in the world, yet Lake Baikal stands apart from all other known reservoirs. People from all over the world come to the Soviet Union just to see the famous lake.

What makes it remarkable is the fact that there is no other lake anywhere on Earth as deep as Baikal.

In some places its bottom drops to 1.7 km below the surface. The most remarkable feature of this lake, however, is its crystal clear water, so limpid that one can easily see the bottom through 40 meters of water. The volume of water in Baikal, which contains one fifth of the world's fresh water reserves, is approximately equal to the annual runoff of all rivers on the globe.

More than 300 tributaries, big and small streams, flow into Baikal and only one river flows out of it, the mighty Angara. Today this beautiful river runs the turbines of two high-power hydroelectric stations which generate the cheapest electric power in the Soviet Union.

Lake Baikal is more than 630 km long, and it often happens that in one part of this glorious Siberian "sea" storms are raging while at its other end the water is perfectly calm. It takes a full six days for a passenger ship to make a round trip along its coastal line.

The water in Lake Baikal is cold all year round. At only 300 meters down, the temperature never rises above 4 C, while the temperature of the upper layers rises to some 12 to 15 C only in the summer months. This is why only those who are used to cold water can enjoy bathing in Baikal.

Its flora and fauna are also highly unusual. The lake is inhabited by about 1,800 plant and animal species, out of which number three-quarters are endemic to it. This is attributable to the fact that Baikal is not only a very ancient but also a very isolated body of water. According to scientists, the lake is 25 to 30 million years old. This time is long enough for the development of animal and plant species the likes of which do not exist elsewhere.

The most famous species in Baikal is a fish called the *omul*, a local delicacy. An unusual fish is the *golomyanka*, a small and very beautiful species. It is so white that it looks almost transparent. It has very large pectoral fins; their length is two thirds that of its body. When the golomyanka opens the fins, they

Baikal is the deepest and cleanest lake in the world

look like an umbrella which supports the fish as it drifts with the current.

The golomyanka is found at great depths (up to 1,000 m below the surface) and can easily sustain sharp changes in hydraulic pressure. At the same time, this small fish cannot take temperature changes and dies when the water temperature rises above 10° C.

Finally, a few words about a bold hypothesis advanced by Soviet scientists, explaining the amazing purity of Baikal water. The rivers flowing into the lake bring in a great amount of different dissolved substances, but in spite of this the water in Baikal is purer than it is in its tributaries. This means that the purification process takes place in the lake itself. In their search for the key to the

mechanism of this process, the scientists discovered that the deeper they took the samples, the cleaner was the water, and the lower the concentration of minerals in it. The only explanation for this is that down below, somewhere on the bottom, is a powerful source of ultrapure water. Over hundreds of thousands of years this source has maintained the purity of Baikal by continuously bringing in water from the underlying formations. This hypothesis is supported by some facts. It is well known, for example, that the salinity of ocean water decreases somewhat at greater depths. The causes of this phenomenon could well be the same as with Baikal: fresh water from the underlying formations enters the bottom layers of oceanic water. But where it comes from, and in what amounts, has yet to be found out. In either case, however, the new hypothesis increases the importance of Baikal as a truly unique source of high-quality fresh water for future generations.

At present Lake Baikal has been put under the protection of the Soviet state. To preserve the inimitable beauty of its environment – of Baikal itself and of its islands and its shores, and of the mountains and forests around the lake – it was decided to set up a state national park in an area of 85 thousand square kilometers.

Sarma the Wind

OUR PICTURE OF LAKE BAIKAL WOULD BE incomplete if we did not tell about the winds there – nearly always unheralded, uncommonly fierce and sudden.

This is what the Siberian writer Dmitry Milyukov wrote about the *sarma*, a wind of gale force.

"The storm clouds blotted the sky in a moment, the air grew cold. The people somehow lost all interest in the beauty of the Baikal scenery, and left the shore. Only Radnai and Ivan, two friends, remained on the shore to see what was coming. The sarma swooped down

in a violent gust. The wind sharply changed its direction and kicked up a thick cloud of sand and dust along the coast. The waves seemed to shrink, but the next moment they rose high and, roaring and sputtering, sent up fountains of water. Then came another violent gust that chopped off the fountain tops and scattered them about the shore.

"Radnai, huddled and cold, looked around, wondering if he could find shelter for himself and for Ivan from the wind and scud. Ivan, instead, was jubilant. Here at last he could see the sarma in all its furious glory! And inside him another storm was raging and seething, about to burst out. And with every gust of the wind Ivan felt like screaming to the elements: 'Come on! More, more!' And the sarma blew with a vengeance. Somewhere very near where they were standing a pine tree was uprooted and thrown to the ground. Yet Ivan kept on asking the sarma for more noise, for more rumble, and for more devastation. The waves were now reaching the boat farthest away from them.

"'Let's go and pull her up!' shouted Radnai. 'Baikal has gone mad...'

"Crazy sarma! Ivan asked it to calm down, but he no longer had any control over it. The wind whipped up the waves with such force that they shot up suddenly like tongues of flame. Ivan was bewildered. The boat was suddenly pulled downwards. A huge wave crashed upon it, tossing it around, knocking out the fish, the oars, the bunks and even the dented mess-tin. Ivan and Radnai found themselves in the water. When they emerged, the wave had rolled far ahead leaving some choppy ripples behind it:.."

The word *sarma* was borrowed from the name of a river that flows into Baikal near Olkhon Island. Sarma is one of the thirty local winds. This north-westerly wind is at times so strong that it easily sweeps large stones into the water and raises waves five and more meters high. On days like this Baikal is formidable. The dark sinister clouds slide down from the mountain tops to the

very edge of the water. Loud noises and whistle rise in the air, as if coming from the infinite depths of the lake. The noise is punctuated by loud splashes from stones falling into the water. Water spouts appear over the surface of the lake. About half the shipwrecks on Baikal are linked to this wind. Even large ships hasten to take shelter from the sarma.

Another north-westerly wind, no less fierce, is called the *gornaya* (mountain wind). The speed of the air currents which it creates over the mountains near the shore is 40 meters per second and even faster. This wind can start up in almost all parts of the lake and is particularly strong off the western coast in autumn.

By their nature the sarma and the gornaya are what may be described as runoff winds, i. e. air currents that descend from mountains into low-lying areas. Such winds could well be compared to air avalanches.

The best known of such "avalanches" is the one that often occurs near the city of Novorossiisk on the Black Sea coast. This wind is called bora. Similar winds occur in the Far North, notably over Novaya Zemlya and in the Kara Sea.

Actually, the Baikal gornaya and sarma are variations of the borás that occur near Novorossiisk and in Novaya Zemlya. Baikal is surrounded by high mountain ridges separated by narrow river valleys. In late autumn when cold weather sets in in Siberia, Baikal stays open for a long time yet. A low air pressure zone is formed over its surface, for the simple reason that the temperature of the water is much higher than that of the air. When cold air masses come here from the Arctic they stream down the coastal mountain valleys towards the water surface. The air descends from the mountains so suddenly and with such tremendous force that it even knocks animals off their feet.

Most of the Baikal winds give little joy to the local people. There is only one wind, the *shelonnik* that is always welcome. It blows in late autumn from the

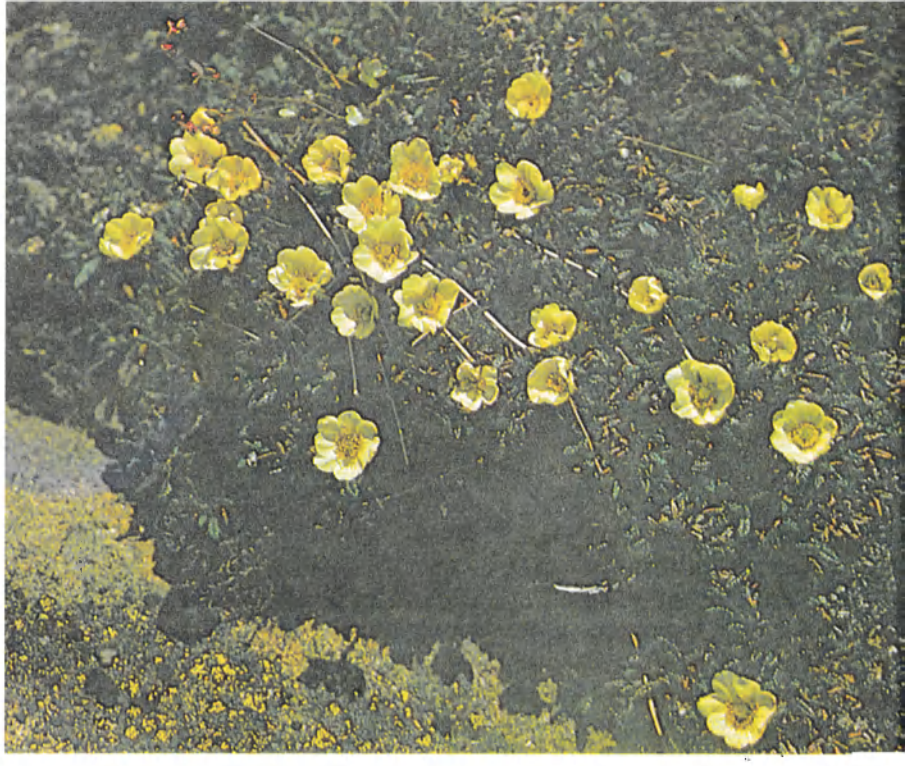
south-east and brings the warm breath of the southern steppes.

From West to East

EAST SIBERIA IS SO VAST THAT ITS TERRITORY could easily accommodate almost the whole of Europe. It stretches in a north-south direction from Cape Cheliuskin (the most northernly point of Eurasia) to Kyzyl, the capital of the Tuva Autonomous Soviet Socialist Republic, the site of a stone obelisk marking the heart of Asia.

A long time ago, in czarist days, East Siberia was thought of as "land's end", a vast inhospitable, barren wilderness where the autocratic regime exiled revolutionaries and other "undesirables". Many nationalities who had lived here from time immemorial were on the verge of extinction. The transformation of East Siberia, its industrialisation and cultural development began after the Great October Socialist Revolution of 1917. The volume of industrial production here has since grown more than hundred-fold, and the world's biggest hydro-power stations have been built on its rivers. All the small nationalities of East Siberia, who before the Socialist Revolution were totally illiterate, have written alphabets of their own, which enables them to write books in their languages. You can find in the administrative map of East Siberia the Yakut, Buryat and Tuva autonomous republics, the Khakass Autonomous Region, the Evenk, Dolgano-Nenets and other national districts and areas.

East Siberia is rich in raw materials used in the production of aluminum, and has large deposits of tin, and rare metals. Tin, tungsten and molybdenum are obtained in Khakassia and in Transbaikalia; nickel, cobalt, copper, platinum and other rare metals are mined near Norilsk in the Far North, and diamonds in Yakutia. One of the leading industries in East Siberia is gold mining.



Spring is the best season in the tundra

The natural environment in East Siberia is extremely varied, with vast mountain areas alternating with lowlands. The tundra of the north gives way to coniferous forests stretching over thousands of miles. Further south, in intermontane depressions, there are some steppe areas.

In his book "Discovering Siberia" Alexei Okladnikov, Member of the USSR Academy of Sciences and a well-known explorer of Siberia, describes a trip he made deep into the Sayan taiga:

"In winter, the icy road follows the bank of the Uda River, and partly over the ice of the river itself. The river valley is narrow, wedged in on either side by high cliffs. The bank rises sheer from the river bed to as

high as 200 to 300 meters. The bluff is edged with cliffs that stand out like pillars. The most striking of these is the pillar called the Belfry. It comes into view suddenly. Its top looks as if it was chopped off by the hatchet of some giant hero from a fairy-tale. And then you get to a place unimaginable in its pristine grandeur. Even the most celebrated spots in the Alps, even the thousand-times lauded Saint Gotthard, pale before the Belfry, which so suddenly rose in our way."

In summer the roaring stream at the foot of this cliff whips up its waves into a froth, and in winter icy hummocks rise higher and higher. Some huge rocks have been upended, others piled up in heaps. They are dark blue by moonlight, green and bright blue in the sunshine, and rosy and even dark red at dawn and at sunset.

...Still further ahead lies the Soviet Far East, the easternmost part of the Soviet Union. The Soviet Far East comprises the Primorski Territory, the Khabarovsk Territory, the Magadan Region with the Chukotka Autonomous District, the Kamchatka Region with the Koryak Autonomous District, and the Amur and Sakhalin regions.

The scenery of the Soviet Far East is fabulously beautiful. No wonder it has always attracted people but only courageous people.

The Magadan Region is the most north-easternly part of the Soviet Union. Less than a hundred years ago this area had almost no population. The severe climate, the tundra and the total absence of roads prevented the development of this vast territory. Could anyone in those days even think that Magadan would be the USSR's major producer of gold, tin and tungsten; that it would have a developed fish-processing industry, a timber-processing industry and an ore-mining industry; and that a large modern city, Magadan, would rise on the coast of the forbidding Sea of Okhotsk? Today all that has become a reality.

The biggest river of the Soviet Far East is the Amur

which is navigable over its entire length. In 1932, large groups of young people, all of them members of the Komsomol, landed on its banks to build a city, Komsomolsk, amidst swamps and forests. That was a priority building project of those days. Today Komsomolsk-on-the-Amur is a large industrial and cultural centre of the Soviet Far East. Among its industrial enterprises is the Amurstal steel smelting plant, the first of its kind in this area.

The Amur's main tributary is the Ussuri River which flows amidst the most remarkable wildlife area in the whole of Siberia and the Far East. Here larch and pine grow side by side with apple and pear trees. The mighty cedar pine, tall as a ten-storey house, yields a whole 100 kilograms of nuts per tree; also here grows the cork oak. These trees are interwoven with lianas and wild grapevines. This is a place where the subtropics come together with the Russian North. The various plants have formed a multi-tiered impassable thicket. In May and June, the Ussuri forests are in bloom. The first to open up are the buttercups, rhododendrons, apple trees and the bird-cherry trees; after that come the jasmine, the Dahurian rose, and the Amur lilacs...

As if oblivious to the winter colds which in the Ussuri Territory reach 30 C below zero, tigers and leopards, the tropical drongo and the Indian oriole live here side by side with the reindeer from the Arctic. Also here you can see giant two-meter Schrenk boa constrictors.

...In 1965, Alexei Okladnikov, who had devoted many years of his life to the exploration of Siberia and the Far East, surveyed a remarkable cave in the Primorski Territory. On one of the walls of the cave he found an image of a woman's head hewn in stone. Who was the sculptor? Could it be an ancient artist who lived here dozens of thousands of years ago? Or was this human head sculpted by a hiker not so long ago? To clear the matter up, Okladnikov brought a team of archeologists to this cave known as the Cave of the Sleeping Beauty.

This is what he wrote. "The first hall was nothing short of resplendent: spacious, with a high ceiling and with a smooth floor which sloped gently into the cave. Sunlight penetrated through the entrance but further in the cave, the light grew dimmer and dimmer. Right at the start we saw incredibly rich dripstone deposits. There were no glistening stalactites, though, or tall white columns like those in a Gothic cathedral, but nature had lavishly decorated the major chamber of the cave with fanciful limedrips. Many of them looked like veritable sculptures fashioned by nature itself. Protruding from a cold rough wall in the grotto was a huge humpbacked monster with a long elephant-like trunk."

And there it was, the goal of the expedition. Standing out of the upright dark wall was a lifelike human face. It was immediately obvious that it was a woman's head with graceful facial features and thin lines that formed her eyes and mouth. But when you looked at the sculpture in profile, it changed its aspect, with the resolute lips and squinted eyes projecting cruelty and inner force. Recalls Okladnikov: "We immediately discarded the idea that this could be a fake made – just for the fun of it – by some artist of our own time. The sculpture bore the clear imprint of ages long gone by. It was obviously the work of a real artist who had reached the pinnacle of cultural achievement of his time. But what time was it?"

One can imagine what moved the ancient artist to make this sculpture. On the walls of the cave he must surely have seen the quaint patterns resembling monkeys and elephants; enigmatic masks and chimaerical images looked at him out of the darkness. And then he saw a beautiful, very life-like human face. The only features missing were the eyes and the mouth. In a surge of inspiration he took his instruments – these must have been a knife and some jagged tool – and cut in the soft rock a few lines that completed the image he had fancied in his mind...

"We suddenly discovered still another sculptured image

on the left wall of the great hall. Staring down from a height of three meters was a threatening countenance executed in the same manner as the first one. Here, too, the unknown sculptor used a stalagmite whose shape prompted an unexpected turn of the head."

That was how archeologists discovered a bona fide subterranean museum of ancient art on the obscure river Suvorovka in the Primorski Territory. This means that in the remote past, some people with a developed original culture lived in the Far East. "In the cave on the Suvorovka the explorers came in touch with a hitherto unknown seat of culture of some time in the remote past, a culture that is as fascinating as it is enigmatic. Archeologists don't know yet what new discoveries might be in store for them," wrote Academician Okladnikov.

Stars from Yakutia

YAKUTIA, IS THE NORTHERNMOST AUTONOmous republic of the Soviet Union. Almost half of it lies beyond the Arctic Circle. This is a cold, harsh country, with winters lasting eight months a year. The world's lowest winter temperature readings (70 C below zero) have been recorded in Yakutia with two cold poles – one at Verkhoyansk, an old Yakutian town, and the other at the village of Oimyakon on the Indigirka River. In this land with extremal natural conditions the annual temperature gradient, i.e., the difference in air temperatures between the severe winter and the hot summer, exceeds 100 degrees Centigrade.

The harsh climate leaves a marked imprint on the life of people here. For instance, houses in Yakutia are built with very thick walls, and windows have three glass panes, rather than two. The windshields of motor vehicles are also made of two glass plates. The northerners have lots of problems with machinery because at the temperature of minus 60° C, many varieties of steel and

other metals lose their resilience and strength, and rubber becomes as fragile as glass.

The whole of Yakutia lies in the zone of permafrost many hundreds of meters deep. In Yakutsk, for example, the permanently frozen soil layer is 450 m thick, at the town of Mirny, the centre of diamond mining, 550 m, and in the north-western part of the republic, 1.5 kilometers thick. However, when the ground thaws out a little in summer, it can be used for farming. The collective and state farms south of the Arctic Circle grow potatoes and vegetables, and further south – barley and rye. Surprisingly, in some places permafrost overlies whole seas of hot water! This was discovered by deep drilling. At the bottom of one well, at a depth of about 2.5 km, the water temperature reached 50 °C. In the upper reaches of the Indigirka there is a hot water spring which plays all year round. Local people think it has some therapeutical properties and use it for bathing.

Sometimes, as they force their way to the surface through a thick layer of permafrost, such hot springs form ice crusts which subsequently develop into veritable mountains of ice. The summer is short in the north, and the sun does not have enough time to melt all this ice. Reindeer breeders have converted these ice mountains into regular refrigerators by hewing niches and keeping food in them.

Northern Siberia is richly endowed with natural wealth: timber, gold, tin, rare metals, mica, coal, iron ores and natural gas, to mention but a few. Built here in the past few years were a major ore-enrichment facility near Oimyakon, another one at Udachnoye, and a hydro-power station on the River Vilyui. About thirty years ago, commercial production of diamonds was started here.

The history of the discovery of diamonds here goes back to the beginning of this century. A Yakutian reindeer breeder once found a glistening stone on the banks of

the Vilyui. "Looks like an icicle except that it does not melt in the hand," he thought. So he gave the stone away to a merchant in exchange for two pounds of tobacco. The Yakutian thought it was a bargain: after all, what is a little stone to tobacco? Soon after, the "little stone" was put on display at the world exhibition in Paris and became known as the Polar Star. It weighed 50 carats.

For obvious reasons, the merchant did not say where the diamond had been found. A few decades later Soviet scientists discovered diamond deposits in Siberia by scientific prevision. They noticed that what is known as the Siberian platform the territory between the Lena and the Yenisei – had basically the same structure as the South African platform with its rich diamond deposits. In South Africa diamonds lodge in kimberlite, hypogene rock once extruded to the surface by powerful explosions of the gas that had accumulated in the abyssal regions of our planet. There it hardened in the cracks and crevices of the Earth's crust, forming giant kimberlite pipes that go deep underground. In the USSR no such pipes had yet been found. Could it be that they would soon be discovered? The answer to this question could be given only by wide-ranging geological prospecting which began in the late 1940s. Well-equipped teams of experienced geologists went to the taiga wilderness of northern Siberia and soon reported their first discoveries.

In the spring of 1948, the first Siberian diamond was found on the banks of a tributary of the River Lower Tunguska. A year later placer diamonds were discovered in the middle reaches of the River Vilyui. However, the big question of kimberlite pipes on the Siberian platform remained unanswered. Finally, in the autumn of 1954, the first kimberlite pipe was found. It was called Zarnitsa (lightning). In the summer of the next year, geologists Khabardin and Yelagina hit upon a rich diamond deposit which they called Mir (peace). Soon thereafter, Mirny, a new diamond mining commu-

nity was built on this site.

Recalls Yuri Khabardin: "On June 13, 1955, Katya Yelagina and I were walking along the River Irelyakh. Near a gully on the left side of one of the streams we took a soil sample. I began to carefully wash it, and there in the trough I saw tiny blue pieces of kimberlite. We had no doubt that we had discovered a primary deposit that we had been looking for so long. But how should we report this discovery on the radio? We would have to tell about it in plain language, yet in a way that only the initiated would understand. The important word was 'pipe', the usual designation for kimberlite deposits. What could the best name for it be. The bitter memories of the recent war were still fresh in our minds. So we coined this cryptic phrase: 'I've lit upon a pipe of peace.' To give the idea of the value of the new diamond deposit, I added: 'The tobacco is superb.'"

Some of the specimens found in Yakutia are jewels of rare size and beauty: Maria of 106 carats, Stalingradsky of 166 carats, Mirny of 56 carats, Golden Prague of 40 carats, and Leningradsky of 44 carats.

The biggest diamonds found in the Soviet Union are the Star of Yakutia (232.1 carats) and Revolutionary Ivan Babushkin (171 carats). The latest find at Mir was a jewel with a yellowish tint the size of a chicken egg. It weighs 342.5 carats, which is almost 70 grams.

The Tungus Miracle

THERE IS A LOT MORE THAT COULD BE SAID about the vast land of Siberia, about its wealth and its people. But since our aim is to introduce the reader to some of the rare natural phenomena and facts, we shall tell about a new science called meteoritics, which began with studies of the meteorites found in Siberia.

In the 1770s, Pyotr Pallas, a member of the Academy

of Sciences of Russia, came to Siberia. Pallas was one of the first scientists to study the natural environment in this part of the world. When he came to the Yenisei he was told about a lump of native iron found in the taiga. Pallas immediately understood that there was some mystery attached to the unusual find and took the metal to St. Petersburg, the capital of the Russian Empire. There the iron caught the attention of another scientist, Ernests Hladni from Riga. As often happens in scientific research, Hladni got onto the right track because of a phrase in Pallas's records: "Local people said that the iron lump had fallen from the sky."

The point is that Hladni had for several years been studying bolides, big brightly luminescent meteors. A bolide looks very effective in flights: a large ball of fire appears in the sky, leaving a long brightly luminescent trail. Then it disappears beyond the horizon. The flight is often accompanied by sounds. Nobody knew at that time what bolides actually were. Hladni was the first to understand that these are meteorites, or pieces of rock from outer space, that fall upon the Earth's surface. When entering the Earth's atmosphere, even a little piece of cosmic matter flares up and looks like a large luminescent ball.

Hladni studied such stones and came to the conclusion that they were in many ways different from stones of terrestrial origin. When he learned about the Siberian find, Hladni made a detailed study of the "Pallas iron", as it was then known. Upon close examination it proved a "relative" of the celestial stones that descend upon Earth from outer space.

After that Hladni no longer had any doubt that stones could fall to Earth from outer space, thus challenging the scientists' prevalent view in those days that this could not be so. The research carried out by Hladni, a corresponding member of the Academy of Sciences of Russia, met with much hostile opposition from his colleagues. Hladni parried their criticism: "Some people

prefer to stay within the narrow limits of existing notions and dismiss everything else as paradoxical. It has always been that way: the ideas which multiplied our knowledge about nature have always seemed to some people to be something incredible... If we are to abide by old views, mankind will forever continue in the state of infancy and ignorance, or will inch along at best."

Only a few years after Hladni first propounded the view that celestial stones could fall, and did fall, upon our planet, the following episode convinced scientists that he was right. In 1803, about three thousand small stones from the sky bombarded the town of L'Aigle in France. That day, after its mayor sent a dispatch to Paris about the event, one of the newspapers in the capital expressed its condolences to the residents of L'Aigle over the gullibility of their mayor. Nevertheless, the government sent a representative of the French Academy of Sciences to the scene of the occurrence. When he came and saw for himself that the rockfall had actually taken place, the Academy admitted that stones could fall from the sky. That was the day a new science, meteoritics, was born.

The study of meteorites which began at that time was of tremendous significance for the progress of science. For meteorites were neither more nor less than samples of matter of non-terrestrial origin. By studying their structure and their composition scientists hoped to learn about the chemical elements that other celestial bodies consisted of.

The study of "celestial stones" yielded more proof of the unity of the Earth and the sky: matter found in outer space contains the same chemical elements as those on Earth. None of the meteorites had any elements that do not exist on this planet. Meteorites are just another form of the existence of matter in this solar system. They consist of the same matter that at some distant time brought forth the Earth and all other planets. The study of "celestial stones" has shed light on the origins

and development of the planets of the solar system, including the planet Earth.

Large stones form a separate group among meteorites. A legend born on the Estonian island of Saaremaa describes the origin of a perfectly round lake on this island. Years ago the place of what is now a lake was the site of a rich estate whose owner flouted all human laws. He fell in love with his own sister and decided to marry her. The sister did not dare to resist him, but she was never to become the wife of her blood brother: when the wedding began, the mansion fell through the ground, leaving a lake in its place.

That is what the legend says. In actual fact, about 2,700 years ago the island was struck by a giant meteorite which exploded on impact, forming a crater, 110 m in diameter and 12 m deep. Scientists who studied the crater discovered seven more meteoritic craters of smaller size elsewhere on Saaremaa. Quite possibly the "celestial stone" had split up in flight and its splinters left their marks on the ground.

Several more meteoritic craters appeared quite recently, in February 1947. A gigantic meteorite (asteroid) fell in a thick forest in the spurs of the Sikhote Alin mountain range in the Soviet Far East. As it fell, it lit up the area so brightly that the trees and other objects cast shadows on the ground; the noise the asteroid made was as loud as an artillery salvo. The shock wave from the impact smashed the windows in many houses. That was an iron meteorite which broke up into thousands of big and small splinters while still in flight. Besides iron meteorites (siderites), there are also stony-iron (siderolites) and stone ones (aerolites).

Over the years scientists have found many traces of big meteorites on Earth. For instance, as was recently established, Lake Elgygytgyn in Chukotka owes its existence to an asteroid that struck the Earth five million years ago. The impact formed a crater seventeen kilometers in diameter and a thousand meters deep. This was established

by the Geology Institute of the Academy of Sciences of the Ukraine upon examination of the bottom of the lake and the surrounding area.

A giant bowl-shaped depression, about one hundred kilometers in diameter, has been discovered in the basin of the River Popigai some 250 km from the coast of the Arctic Ocean. Scientists have advanced different hypotheses as to its origin. Many believed that the depression was actually an extinct ancient volcano. In 1970, the researchers working there finally came to the conclusion that about thirty million years ago, this planet collided with an asteroid 1.5 km in diameter. The space giant penetrated more than a thousand meters into the earth and then exploded.

Finally, a few words about the mysterious object (either a meteorite or a comet) that fell on Earth early in this century. That happened on June 30, 1908, a short distance from the River Podkamennaya Tunguska in the northern part of Siberia. Eyewitnesses said that the bolide which appeared in the sky at about 7 a. m. shone as brightly as the sun. The celestial body fell in the taiga away from populated areas. It rammed the earth at great speed and then exploded like a bomb. The explosion, which was heard more than a thousand kilometers away, destroyed a large area of forest and sent strong tremors which were registered throughout the world as an earthquake.

The "Tungus miracle" remains a scientific enigma unresolved to this day. The scientists who examined the expected area of its fall did not find any remnants of the "celestial visitor". The research is still going on but most specialists believe that what has come to be known as the Tungus meteorite was most likely the nucleus of a small comet which exploded upon entry into the dense layers of the atmosphere.

Another question raised by scientists studying "celestial stones" is this: could it be that meteorites bring to Earth some organic substances capable of sustaining life?

Back in the last century, researchers tried to find water in these stones, for, as is known, no life is possible without water. The presence of water was finally established in 1944. Then followed still more major discoveries. In 1969, a meteorite was found to contain eighteen amino acids which, as is known, form molecules of protein. The question suggests itself: could it be that the organic matter brought to Earth this way eons ago gave a start to life on it? And is there life elsewhere in the universe besides Earth?

No definite answer has yet been found to this question.

Fire-breathing Mountains

WHILE WE ARE IN THE SOVIET FAR EAST, LET us pay a visit to Kamchatka. This peninsula stretches from north to south over a distance of 1,200 km and is bounded by the Pacific Ocean and the Okhotsk and Bering seas.

There are many things here that are, at first glance, unusual. In winter people sometime have to literally break their way through the snow, which can bury a house up to its rooftop in just one night. And a few hundred yards away, you can see people bathing in a small lake, where the water temperature can reach 25 to 30 C. In some places hot water springs play all year round. Especially famous in this respect is the picturesque Geyser Valley which attracts tourists from all over the world.

Another remarkable feature of the Kamchatka Peninsula is its high tides. In Penzhinskaya Bay, for instance, the tides rise to as high as 10 meters.

There are many active volcanoes in Kamchatka. The biggest of them, Klyuchevskaya Sopka, is 4,750 m high.

Among many natural phenomena very few can rival volcanoes for their formidable power that destroys everything in its path.

On a small island in the Sunda Strait between Sumatra

Kamchatka

and Java is the volcano Krakatoa. For a long time it was dormant; then, suddenly, in the spring of 1883, it came back to life. During the eruption the volcano ejected so much ash and stones that the island became twice as large as it had been before the eruption. And then one day in August of that year Mt. Krakatoa exploded. The explosion was heard thousands of miles away and the shock wave it sent was so powerful that it smashed the windows in houses on the island of Java, some 230 km away. The mountain disappeared, leaving a deep depression which was then flooded by the sea. Powerful waves surged upon the nearby islands, washing off dozens of villages and several towns. The huge wave raised by the subterranean explosion rolled across the

Pacific Ocean, reached the coasts of America and Africa, rounded the Cape of Good Hope and finally reached the coasts of Britain and France! Some sailors who were near Krakatoa at that time described what happened there. When the eruption started their steamship was in a bay in the island of Sumatra. A giant black cloud covered the sun and then began to shed ashes and thick, sticky mud. The sailors could hardly breathe because the air was thick with noxious gases. The surface of the sea looked like a seething cauldron. Many people thought that the end of the world had come. The eruption took 36,000 lives.

It is estimated that over the past nine thousand years there have been about 5,500 volcanic eruptions. Some of them even changed the course of history. In 1470 B.C. a powerful volcanic eruption on Santorin Island in the Mediterranean destroyed a whole civilisation. It is believed that this catastrophe brought forth the legend about Atlantis.

It is little wonder that fire-breathing mountains have since time immemorial been deified and have numerous frightening legends connected with them.

But what really happens in the bowels of the Earth, and why do volcanoes explode?

Temperatures deep inside the Earth are very high, partly due to the presence of radioactive substances. The spontaneous decay of these substances produces energy that heats up rock. High temperatures inside the Earth are also due to the pressure that the upper layers bring to bear upon the lower layers; this also leads to the heating of subsurface rock.

It would be logical to assume that at these high temperatures all substances in the bowels of the Earth should exist in a molten or even gaseous state. This, however, is not the case. It has been proven that the Earth is mostly made up of solid matter because of the tremendous compression caused by the overlying layers. It is only where this pressure eases up that the hot solid

The lake in the crater of Maly Semyachik, an extinct volcano

masses become molten, forming magma, a liquid incandescent mass.

The external mantle of the Earth, the crust, is in a continuous state of flux. Forces within the Earth keep changing its surface by turns raising and lowering continents and forming mountains and valleys. In most cases such changes are slow and imperceptible to the eye, but sometimes the layers of the Earth shift suddenly, causing earthquakes.

Such shifts produce deep fissures in the Earth's crust, relieving pressure and giving way to magma which either fills the numerous crevices, hardening in the form of veins, or breaks out into the open.

The magma contains a large amount of different gases.

As soon as they get into the upper layers of the Earth's crust, these gases leave the magma and burst out to the surface. This is why at the start of a volcanic eruption a column of smoke – a mixture of water vapour, hot gases and ash – rises above the crater. The spouting gases also eject fine volcanic dust and even pieces of rock. The internal pressure is so great that the stones shoot out of the crater like cannon balls up to several kilometers high. After that the magma itself erupts to the surface and, white-hot and dazzlingly bright, it spills over the edge of the crater and streams down the slope of the volcano like a river of fire, burning everything in its path.

The magma that has spilled out to the surface and lost most of its gases is called lava.

Researchers have found that volcanic activity usually begins at depths between fifty and a hundred kilometers below the surface, yet it is also possible that magma chambers are "nourished" with matter rising from an even greater depth.

The main "trigger mechanism" which initiates eruptions is probably activated by gas accumulations in the magma. When the pressure of the gas exceeds the pressure of the strata constraining it, a catastrophe is imminent.

For thousands of years, volcanic eruptions have been a major source of superstition among different peoples about the formidable unknown forces of the nether world. Today the perceptions have changed; when people encounter unknown phenomena they are guided by a desire to get to know more about them, rather than by superstition or fear. Scientists climb right into the "devil's maw", as volcanoes are known, defying the obvious danger and risking their lives. Living and working right next to volcanoes are volcanologists who study eruptions, their characteristics and regularities. All the knowledge about volcanoes thus obtained is extremely valuable for science and practical applications. In view of this, the

An eruption of Mt. Tolbachik

USSR Academy of Sciences has set up a specialized volcanology institute in Kamchatka.

Shortly before an eruption, when the magma is beginning to move in the Earth's interior, the soil underfoot starts vibrating, which is easily established with seismographs and tiltmeters. Other instruments detect specific subsurface sounds that usually herald a volcanic eruption.

...A typical seismographic station near a volcano will initially record one signal coming from the interior of the Earth; thereafter, the seismographs register more tremors, their frequency increasing to two or three a day. The power of the tremors also grows at an increasing rate. The volcanologists then analyze the recordings and estimate the date when the eruption is expected to occur. As a rule, the date is predicted seven to eight days before the actual eruption, the margin of error being two to three days.

Scientists have established that some changes occur in the composition of the gases emanating from the crevices inside the crater before eruption. The temperature of the gases rapidly rises, which facilitates prognostication. There are also some other signs which can indicate an impending eruption.

In 1964 Soviet scientists made an accurate forecast of an eruption of Mt. Shiveluch in Kamchatka. Shortly before the eruption, Shiveluch began to tremble feverishly. The next morning it "spoke up"—like thunder. Here is an eyewitness account:

"The eruption of Mt. Shiveluch did not come as a surprise to the volcanologists. Back in April, when the volcano had awakened after being dormant for many years experts predicted that Shiveluch would explode in November...

"We arrived at Klyuchi together with a group of scientists from the Volcanology Institute the day after the eruption. From here our expedition was to go by helicopter to Mt. Shiveluch.

"...With its body, which showed numerous eruption

wounds, spread across the peninsula, the volcano was heaving clouds of white smoke towards the blue sky. Through a stereoscopic telescope positioned at the volcanological station, we could clearly see the crater choking with smoke, and serpentines of steam on the huge greyish pancake of mud. At a distance of several kilometers from the crater, we could see "bombs" – large stones ejected from the volcano – trapped in the mudflow.

"The volcanologists spent the whole day packing instruments and buying food supplies. They would have to work for some three or four weeks on the volcano, where there was not a single tree or bush left, and the air temperature reached 40°C below zero. We were busy making portable stoves and after that tried to find several teams of dogs, which was no easy matter, because all local hunters had gone to the taiga. Finally we found the dogs and were ready for an airlift by helicopter to the volcano. But there was still another hitch: the unfavourable flying weather delayed the departure...

"Unable to resist the wind any longer, the ash cloud heavily separated itself from Shiveluch and slowly moved in the direction of Ust-Kamchatsk. As it moved, the cloud blotted out the morning sun and left on the snow a black streak of dust, some four kilometers wide. After leaving a dust trail of more than 100 km, the cloud finally reached Ust-Kamchatsk, plunging this regional centre into darkness. People trying to find their way were literally groping in the dark. And then there were these flashes of lightning. At Klyuchi, they occurred over the volcano looking like fiery serpents going berserk right before your eyes.

"Then the raging storm left Ust-Kamchatsk, and the wind carried the serpentine cloud away to the Commander Islands and, in a matter of several hours, plunged them into night.

"The next day we finally managed to fly around the volcano in a helicopter, and now had a more complete picture of the eruption. We estimated that Shiveluch had

Volcanic eruptions: the raging elements, the riot of colours

ejected about two cubic kilometers of ash, lava and earth, a job equal to the energy released by twenty medium-sized atom bombs going off simultaneously. The explosion occurred 600 m from the top of the mountain. The crater is not that deep, but in diameter (1.5 km) it has no equal anywhere in Kamchatka.

"The weather never did let the scientists examine the volcano from a helicopter. So the first group set out for the volcano on foot. This meant seventy kilometers of cross-country trek waist-deep in the snow, and dozens of creeks and streams to be crossed. The hot mudflow from the crater had melted the snow a hundred kilometers around."

In 1983, Kamchatka volcanologists successfully predict-

ed an eruption of Klyuchevskaya Sopka, the biggest volcano in Asia.

... A man in a bright silvery heat-repelling suit is filming a volcanic eruption, training his camera now at the rock debris being carried away by the red-hot lava, now at the spray and steam rising up from places where the lava had come in contact with the glacier.

"This is an amazing volcano," said Sergei Fedotov, head of the Kamchatka Volcanology Institute and a corresponding member of the Academy of Sciences of the USSR. "As a rule, volcanoes live tens of millions of years, while Klyuchevskaya is merely five to seven thousand years old. This volcano came into being about the time when the Egyptians were building their pyramids."

The volcano is almost 5,000 meters high. For forty years now a volcanological station has been in operation at the foot of the giant mountain, but still very little is known about the volcano. It is not clear, for example, where the volcano gets all that strength to eject thousands of tons of red-hot magma at a time from a volcanic pipe that starts dozens of kilometers down below the surface. Nor do we know anything about the "roots" of this volcano. This is why any information about Klyuchevskaya Sopka which would supplement that obtained by detection instruments is so important. A film shot by a motion-picture camera would help unravel many of the mysteries of the volcano...

Shortly before the eruption, a group of scientists and a cameraman set out on foot for the volcanic pipe located at an altitude of almost five kilometers.

Afterwards, they gave only a brief account of their ascent: they spent the nights in a tent buffeted by strong winds that threatened to knock it down, had frostbite on their cheeks and fingers (when they started out, the temperature at the foot of the mountain was 20°C above zero, while at the top of the mountain it was 40°C below zero).

The result of this climb was a film called "Above

the Clouds". It showed black charred cliffs and then a fiery stream of lava. Significantly, the eruption itself was filmed at close range.

Thus, volcanoes "coexist" with people who study them. Scientists rely on the latest data and modern equipment as they persistently seek to penetrate nature's secrets and to better understand the mechanics of natural phenomena and a way to forecast them. The ultimate goal is, of course, not only to forecast the behaviour of subterranean forces but also to put them at the service of man.

There is a 5,000-kilowatt geothermal power station near the River Pauzhetka, about thirty kilometers away from the Sea of Okhotsk. Run on hot water springs situated near two Kamchatka volcanoes this station has been in operation for about twenty years. The temperature of the subsurface water heated by the volcanoes often exceeds 200° C. To be more precise, this is not just water but steam ejected to the surface under great pressure and actuating the turbines of the geothermal power plant. The station is fully automated so that people come here only to inspect the equipment and to do maintenance work.

Volcanicity is responsible for the existence of many types of minerals. Man studies the laws of volcanicity in order to be able to prognosticate accumulations of many different types of valuable raw materials.

Volcanicity has many side effects, and here is one of them. The ichtyologists working in Kamchatka have traced a link between volcanic eruptions and fish propagation. They have established, for example, that in about twelve to thirteen years after a volcano has "blown off steam", the fish population in nearby rivers and lakes increases many-fold. What kind of regularity exists between the two phenomena? Actually it is all very simple. Volcanic ash is rich in mineral salts which contain the chemical elements that support the life of aquatic organisms. In the first few years after an eruption the water "enriched" with the volcanic ash becomes an excellent

medium for propagation of diatoms which serve as food for small crustaceans. The latter, in turn, are eaten by the growing fish fry.

This is how volcanic activity makes up, if in a very small degree, for the damage it causes to man.

The Valley of Geysers

KAMCHATKA'S GEYSERS WERE FIRST described in the 18th century by its first explorer S. Krasheninnikov who discovered them in the valley of the River Pauzhetka in the south of the peninsula. Two hundred years later, in the spring of 1941, Soviet geologist Tatyana Ustinova saw a high fountain of hot steam and water – a geyser – in the basin of the River Shumnaya, in one of the less explored areas of Kamchatka. No natural fountains had been discovered there before, so Ustinova decided to explore the area around them. She quickly found many more hot water fountains. This area has since become known as the Valley of Geysers, a major tourist attraction in the Kronotsky nature preserve.

This is what Komarov, a Moscow journalist, writes about it:

"The path we took into the valley was not an easy one, but the view that opened before us had more than made up for all the difficulties of the journey.

"It was a sheer plunge to the bottom of the gorge, as if an angry giant had torn apart the neighbouring mountains to leave this deep gash, with the outside of the crest of the range descending to the valley, and on the other side a narrow gorge coming down to a meandering stream. Rising up from this gorge, white steam was caught by the wind and chased down the slopes every which way, bringing with it the sweetish smell of sulfur alternating with that of hot metal.

Geyser Valley in Kamchatka

"'Well, here we are,' said the guide, a local resident. 'This is the gate of hell.'

"From below came a hissing noise as if from a boiler room with a gurgling adding to the impression.

"Out of the cracks lined with mineral deposits white, buff-coloured, light green—came jets of steam. Miniature 'cauldrons' here and there threw up jets of dark liquid mud. The numerous small lakes burbled with similar greyish-black water. The earth snorted and trembled underfoot, separating us from what seemed to be hell itself with just a thin crust of terra firma. At first this breathing of the land seemed deafening, and its untamable power overwhelming. But then irrepressible human curiosity prevailed and we carefully proceeded onwards.

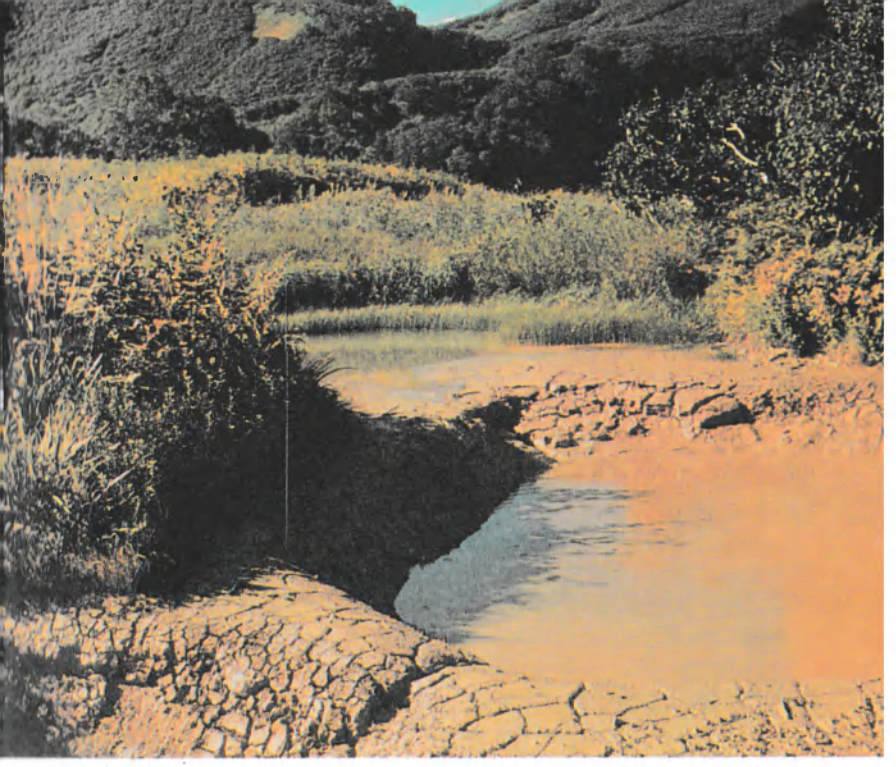
"Suddenly a loud noise came from somewhere down and the echo of it rumbled through the valley. We saw tight sprays of hot water rising high up into the air.

"'Fountain!' shouted the guide trying to make his voice heard over the noise of the steam and falling water. 'Like clockwork: it shoots up once every twenty minutes!'."

Altogether there are twenty geysers and more than a hundred pulsating hot water springs in the valley. Each one of these natural fountains has a temper of its own. Some of them shoot up once every few minutes, with others the intervals last hours. The temperature of the water in these fountains is not the same either.

The eruption of hot water from underground is a magnificent sight. Imagine a small lake with a slightly steaming surface. Suddenly the water begins to boil and gurgle, with foam gathering on its surface. One hears a muffled roar coming from below and then suddenly a jet of water spurts up from the lake. Very often the first such burst is followed by a second, then a third one. Then everything calms down. The geyser seems to be resting and getting up strength for another spurt of hot water and steam.

...We are at the side of the Bolshoi geyser, where seething water is constantly splashing about in what looks



Mud volcano

like a giant barrel. Every forty minutes or so the fountain begins to play. For the first three or four minutes, a pulsating jet of water gushes out to a height of up to twelve meters; then the intensity of the eruption is reduced, the steam pressure abates, and the jet of water becomes smaller and smaller, until it dies down altogether until the next cycle.

The most majestic of all is the geyser called Velikan (giant). This fountain begins to play without giving advance notice. The jet of water it ejects reaches about thirty meters into the air, while the steam rises hundreds of meters high. The picture is accompanied by deafening explosion-like sounds. Scores of rainbows appear near the fountain. About five hours later, Velikan goes into action again, but this lasts no more than a minute, during which

time the geyser ejects up to 30,000 litres of health-giving, mineralised, almost boiling water.

Tourists who come here pay tribute to an old tradition, cooking their meal with the hot water coming from underground.

Another extremely rare phenomenon to be witnessed here is a hot waterfall, coming down from a height of twelve meters.

Islands in the Ocean

THERE IS ONLY ONE ADMINISTRATIVE REGION in the USSR that is separated from the mainland by the sea. This region is made up of the Island of Sakhalin and the Kurile Islands.

People refer to Sakhalin as a small land with great riches. Its mineral wealth includes oil and gas, coal and iron ore, mercury and gold. And its coastal waters teem with fish and fur-bearing animals. The island has much forest, and its land yields good harvests of potatoes and other vegetables.

Sakhalin has a so far unexplained mystery: the island is the only place in the world where grass grows to gigantic size, sometimes three or even four meters tall. And this is grass, not trees! Buckwheat on Sakhalin grows twice as tall as a grown-up man. Cabbage heads sometimes weigh as much as thirty kilograms. Also, grass grows here much faster than on the mainland.

In the last century, one scientist brought back home to Europe the seeds of some gigantic buckwheat in the hope that it would grow as large as it did in Sakhalin. However, nothing came out of his experiment, because in European soil the miracle-buckwheat turned into ordinary buckwheat.

What causes plants grow so fast and to such miraculous size on Sakhalin? Scientists have not yet come up with the answer, although some of them attribute this to some special properties of the soil on that island.

Now a few words about the Kuriles. Here, as geographers say, every island has its own natural environment. There is nothing surprising about that, for these islands – about forty in all – extend from Kamchatka to the coasts of Japan over a distance of close to 1,200 km. Each one of them is a volcano, a splinter of a volcano, or two or three volcanoes together. To be more exact, all these islands are only the tips of volcanoes rising over the surface of the ocean. Stretching across the ocean floor is a tremendous submerged volcanic mountain range that separates the Sea of Okhotsk from the Pacific Ocean. The foundation of the mountains lies at a depth of five to eight kilometers, which makes them into a sort of underwater Himalaya.

As is known, most of the volcanoes of this planet are situated in the Pacific region in the so-called "Pacific fire ring" which embraces the volcanoes of Kamchatka, the Kurile Islands, Japan, the Philippines, Indonesia, New Zealand and the western coast of the Americas. This fiery necklace closes at Alaska and the Aleutian Islands. The Kuriles have about a hundred volcanoes, almost half of them active.

The highest mountain on the Kuriles is Mt. Alaid which rises more than two kilometers high straight out of the Sea of Okhotsk. Over the past two centuries violent eruptions have several times shaken this mountain, changing its shape considerably.

"Mt. Krenitsin on Onekotan Island is magnificent," writes geographer Yu. Yefremov. "The ancient crater of the volcano, which is almost seven kilometers in diameter, is taken up by a warm-water lake of a radiant blue amidst the gloomy cliffs on its shore. The central cone which rose here more recently is a veritable island within an island. The water of the lake surrounds this peak on all sides like a belt, thus living up to its name, Koltsevoye (ring-shaped). I have not been to Onekotan. But even so, looking at the photographs of Mt. Krenitsin taken from an airplane I was struck by the beauty

of the mystery lake, and the forbidding island cone."

Iturup Island looks very much like a huge insect, as it consists of several volcanic cones linked by narrow land-necks. It has an unusual caldera (depression at the top of a volcano) which has been invaded by the sea. This place is called Lion's Maw. Sea waves have chiselled a corridor in one side of the crater and the water from the sea has flooded the lower section of the latter. Standing at the entrance to this rock corridor is a black cliff which wind and water have shaped into a figure resembling a giant lion lying on the surface of the sea.

Everyone who comes to Iturup wants to see the waterfall called Ilya Muromets (after a folk hero of old Russian legends and fairy-tales). The powerful stream falls here from a height of 141 meters. The water gushes almost horizontally from a crevice over a precipice, as if from a gigantic water spout. As it falls, the stream forms a downward curve which is widely deflected – now to the right, now to the left – by the wind which whips it up into myriad drops. The lower section of the waterfall seems to disappear in a grey cloud of spray and scud.

The names of some of the Kurile Islands sound like an ocean tide: Paramushir, Kunashir, Shikotan... These names were given them by the Ainus who once lived here. In English translation they mean "big island", "black island", and "better place"...

Shikotan looks very attractive and fully matches its name – a better place. It has calm narrow fjords, magnificent forests and bright-green meadows. The air is cold and humid at the water edge, while further up on the terraces which rise above the ocean some 200 to 300 meters, the air, brought here by southerly winds, is warm. The island has luxuriant vegetation.

One of the remarkable features of Kunashir Island is its "hot beach". Everybody who has visited the island tells about it. It seems an ordinary beach, but if you

The rugged shores of the Commander Islands

take a good look at it you will see steam rising above it. This is because of the presence of hot ground water. Both the steam and the sand are hot.

... A woman walks out of a house built next to this unusual beach. She rakes apart the sand with a lath and takes out a saucepan. "In the morning I cooked a meal, then put it here so that it would stay warm until lunch time," she explains.

A short distance away, children are baking crabs in the sand which is sometimes so hot here that one can get scalded. It takes only fifteen minutes to cook a giant Pacific crab (a delicacy in many countries of the world)...

There are many natural wonders in the Kuriles, and among them submarine volcanoes, a rare and very impres-

Fur seals on Tyuleni Island

sive sight. There are many such volcanoes in the "Pacific fire ring", and from time to time they show their wayward temper. The picture is frightening. Imagine an endless smooth water surface on a calm day. Suddenly a black column of smoke bursts out of the water. It grows taller and taller, sometimes rising to great heights. Around this tremendous black cloud rage whirlwinds, with thunder rumbling and flashes of lightning piercing the sky... You witness the birth of a new island at initially a little area of smoking solidified lava. In a matter of hours, or in a few days you can approach the new island by boat and even set foot on its surface.

Fur seals and sea lions on the Commander Islands

Seafarers have witnessed the birth of many such islands in various parts of the Pacific. From time to time, newborn volcanoes appear off the Kuriles, too. But after a brief period they literally crumble into the sea, destroyed by waves and currents.

... The Commander Islands. The habitat here is different from that in any other place in the world. Here, on small pieces of land isolated from the mainland is a sanctuary of many rare species, including the fur seal and the sea otter known for their highly valued fur. The sea otter (kalan) which has a soft and silky beautiful fur, is regarded as the most precious marine fur-bearing species in the world.

Overhunting has driven the kalan to the verge of extinction. Measures are being taken in the Soviet Union to save this animal. The latest reports from the Commander Islands are encouraging: the sea otter population is increasing.

One of the Commander Islands is the burial place of Vitus Bering, the leader of an expedition, which has gone down in the history of exploration of the Far East. Born in Denmark, he entered into the service of the Russian Navy and made his home in Russia. In 1725, the Russian Emperor Peter the Great ordered that an expedition be organized in order to explore the coastline of the Far East. The expedition was headed by Capt. Vitus Bering who was to find out if Asia was linked with America. If the two continents were separated by a strait that meant that in future Russia could trade with Japan, China and India by way of a northern sea route.

The expedition lasted more than fifteen years, during which two trips to Kamchatka were made.

... It took Bering and his men almost three years to get to Kamchatka. In 1718, they built their first ship at Nizhnekamchatsky Ostrog. The ship left the mouth of the River Kamchatka and set sail in the north-easterly direction. The Russian sailors reached the strait which led

to the Arctic Ocean and proceeded onward. When he was within reach of the Arctic Circle, Bering spent three days looking for an American coast, and then decided that there was no use sailing any further north, for wherever he turned there was no land, only water. Hence the conclusion: Asia had no land links with America.

A few years later Bering headed the second Kamchatka expedition. This time he came close to the American coast and discovered the Aleutian Islands and the Commanders. He died in 1741 after a shipwreck off one of the Commander Islands, the one which was later named after him. The whole island group was later named the Commanders in honour of the captain-commander who had died there.

Two Fridays in One Week

WHEN SOMEBODY IN THIS COUNTRY IS GIVEN to changing his views or his mind about something he is said to have "seven Fridays in one week". This is just a figure of speech, of course, for there is only one Friday in a week. Yet as it happens, there are some places in the world where there can be two Tuesdays, two Wednesdays, two Fridays, and so on.

If you take a look at a map of the coast line of the Soviet Union in the Far East, you will see that Asia is separated from America by the Bering Strait which in its narrowest part is less than forty kilometers wide. Lying in the strait are the Diomede Islands which include Ratmanov Island and nearby Krusenstern Island. On a clear day, one can see two continents from Krusenstern Island. And that is where you get two Fridays in one week.

The thing is that these two islands are divided by the international date line, where a line marked on the map like a meridian or the equator shows the place where

Here you can have two Fridays – one after the other – in one week

the new days of the week begin. This is why there are two different calendars on these two islands: when it is Thursday on one island, it is Friday on the other. And now imagine the following situation. In the morning a resident of Krusenstern sets out to visit a friend on Ratmanov Island where the calendar shows Friday. The next day he returns home and there his calendar also shows Friday.

The same thing happens on ships and airplanes crossing the international date line. From the Bering Strait this line stretches south across the Pacific Ocean, never touching land anywhere. For the greater part, this line passes along the 180° meridian. When it is crossed by a ship (or an airplane), the date on board is automati-

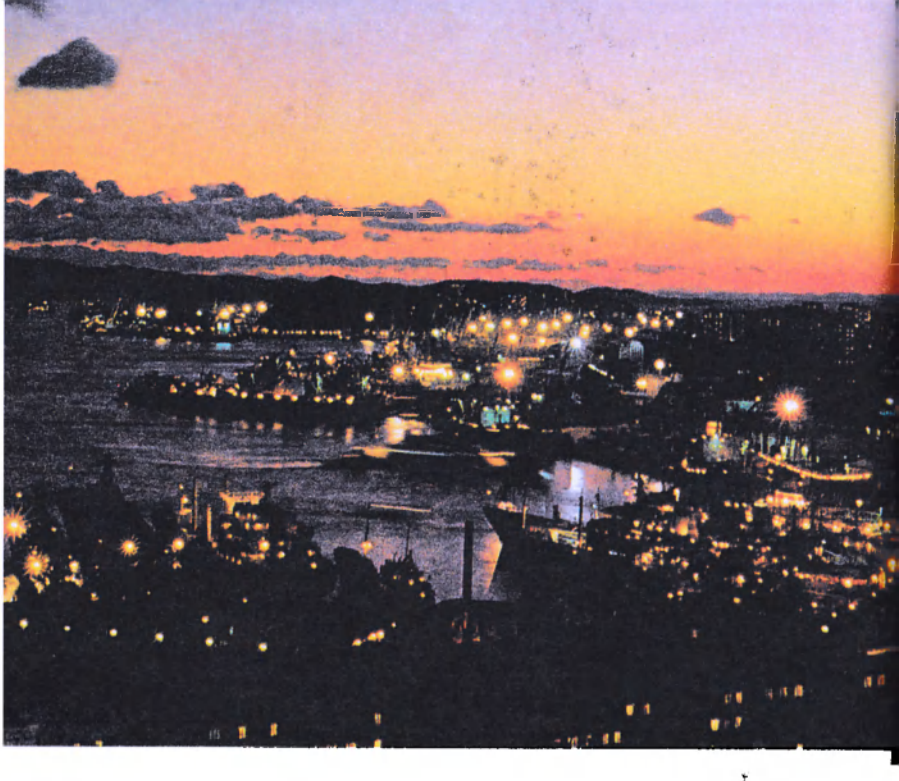
cally changed. For example, ships sailing from America to Asia skip one day, and ships sailing in the opposite direction count one day twice. Imagine two ships meeting on Thursday at a point on the international date line, one sailing from Honolulu to Tokyo and the other from Tokyo to Honolulu. For the first ship, Sunday follows right after Friday and for the other, the next day is Friday again.

It is easy to understand this disruption of the calendar if we recall that the planet Earth makes one revolution around its axis every 24 hours. When we set out in a westerly direction we move against the diurnal rotation of the Earth. And if we continue our movement and circumnavigate the globe we shall have to set back our calendar by one day.

This phenomenon was first noted by Ferdinand Magellan and his crew. Upon returning to Spain, they were surprised to learn that, contrary to their expectations, they had completed their long voyage on Friday and not on Thursday. They had been keeping the log very meticulously, and could not understand how this could have happened. Actually, Magellan's ships had sailed around the world from east to west and had thus completed one revolution around its axis less than anyone who had remained in one place.

Thus, those who had remained in Spain had completed, say, 1,000 revolutions, together with the globe (which was the number of days that Magellan had spent at sea), while the explorers making the trip around the world from east to west counted only 999 days. As many times as the sun rose and set, an entry for a new day was made in the ship's log. However, if Magellan had sailed the other way, from west to east, he would have returned to port with one day extra. To prevent such mistakes, an international date line was set up.

The Pacific coast near Vladivostok

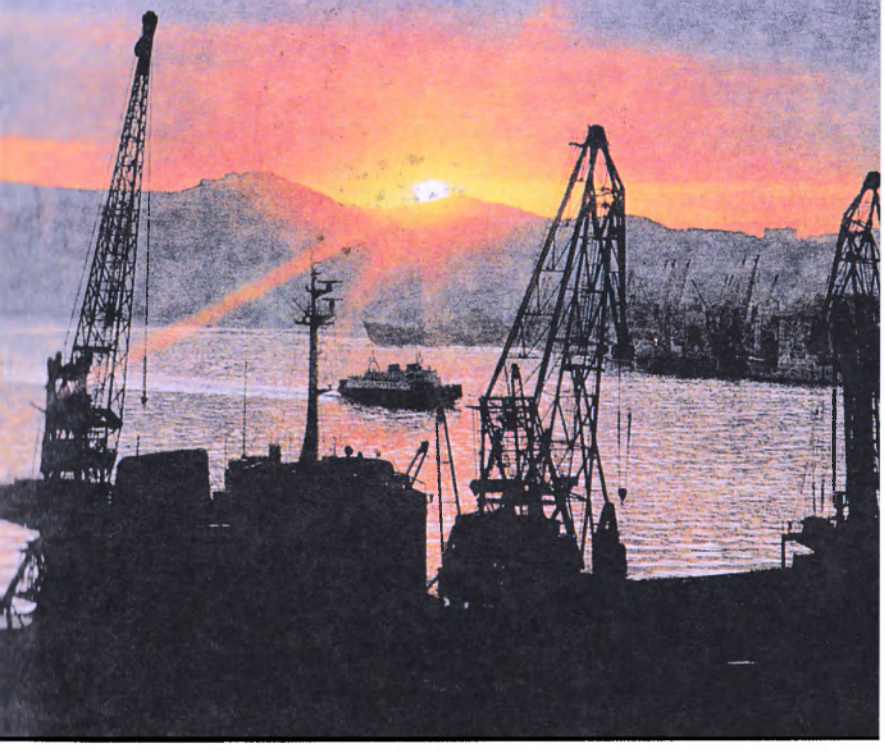


Nakhodka, a seaport

A Land Transformed

TODAY SIBERIA IS A LAND THAT HAS BEEN aroused from sleep, rejuvenated by man's work. In Russia under the czars there were not more than 300 enterprises and factories east of the Urals; today, the number has risen to over 30,000.

Transformed Siberia is the product of the socialist system. About thirty years ago work began on construction of the giant Bratsk hydro-electric power station on the Angara. The station, put into operation in 1967, in the first ten years recouped construction costs seven times over. Every year it generates 22 to 23 billion kilowatt-hours of electric power. Its energy is fed to the



in the Soviet Far East

Bratsk timber-cutting-and-processing complex with an annual output of almost one million tons of cellulose, and to the Korshunov ore-dressing combine with a capacity of fifteen million tons.

Several more hydro-power stations have since been built in Siberia, including the Krasnoyarsk and Sayano-Shushenskaya on the Yenisei and the Ust-Ilim station on the Angara. Together, they generate more than 66 billion kilowatt-hours of electricity per year.

In 1980, West Siberia produced as much crude oil as the whole of the Soviet Union produced ten years before that. In 1985, West Siberia yielded about as much oil as did the United States, the biggest oil producer among the capitalist states. The daily oil output

The early stages of the Baikal-Amur railway building project

of Siberia, despite the harsh climatic conditions there, is more than one million tons.

In winter, the air temperature at the oil fields of West Siberia often stays below 45°C for weeks at a time. At this temperature the air becomes a thick scintillating fog. Metal becomes as brittle as a lump of sugar, so that if you strike a piece of metal with a hammer it crumbles to pieces, or cracks.

The problem of development of the West Siberian oil fields is as formidable as that of developing a new planet, for it calls for the use of special technologies, new machinery, and new road-building and oil-production methods.

And so there came, across the marshy vastness of

West Siberia, the first "bogmobiles"– half truck, half jeep. Out to meet them, raising clouds of fine snow, sailed the air-cushion platforms which, unlike other vehicles, can travel over swamp or water. Special platforms which move on air cushion over land can carry whole oil rigs and dwellings for the oil workers.

A solution was also found to another important problem – the building of reliable roads through the marshlands. The method used is ... artificial permafrost.

In cold winter months mighty bulldozers carefully opened up the icy cover of the swamps to a depth of about one and a half meters. The trench thus built was then filled with snow, packed and then drenched with water. To prevent this road from melting, it was covered with ground, moss and pine-needles. Such roads were operational even in summer!

Thus, Siberians have learned how to combat permafrost where necessary and to create artificial permafrost where it helps them with their work.

An important event in the history of exploration and development of Siberia is the building of the Baikal-Amur railway which passes through areas rich in mineral resources. One need not be a prophet to predict that over the next decade life in many areas around the new railway will be very different from what it used to be.

Siberia has become a truly multi-national land with millions of people who were born far away in different parts of the Soviet Union and who now consider themselves to be true Siberians. They are proud of this, because Siberians have long been known for their courage, strong will and ability to brave hardships.

The native people of the North are also taking an active part in the great transformation of Siberia. Their situation has changed fundamentally compared to what it was before the October Revolution of 1917. The 1899 edition of *Spravochnik narodov Rossii* (The population of Russia: a reference book) had this reference to the Nent-

The giant hydro-electric power station near Krasnoyarsk on the River Yenisei

si: "The tribe is dying out. Population 16,000." In 1913, the Nentsis were described as follows: "Tribe dying out. Population 2,000." The Great October Socialist Revolution saved the Nentsi from extinction. By 1970, their population had reached 29,000. They continue to engage in reindeer breeding, hunting and fishing. But the life they lead now is nothing like it was in the old days. Hundreds of schools have been opened for the peoples of the North in all national districts. The instruction is in their native languages. Books (including school aids) and newspapers are published in their native tongues. There are quite a few scientists, doctors, pilots, teachers and public figures among the Nentsi, Mansi, Yakuts, Chukchi, Evens and Koryaks... Helicopters and

The hydro-electric power station on the River Zeya in the Soviet Far East

other machines have enabled man to reach places where even the native people of the North had never set foot.

Thus the vast regions of Siberia are being developed and transformed by the heroic labour of the Soviet people.

Mountains on the Horizon

Only someone who has been to the mountains (preferably, more than once) can truly understand their inimitable beauty.

The USSR has many mountaineous regions. Mountains take up more than 90 per cent of the territory of the Soviet republic of Tajikistan, with the Turkestan, Zeravshan, Hissar, Kuraminsky and some other mountain ranges stretching over hundreds of kilometers. The south-eastern part of Tajikistan is taken up by the Pamir Plateau (known as the "roof of the world") fringed by such snow-clad giants as Mt. Lenin (7,134 m) and Mt. Communism (7,495 m), the highest peak in the USSR. Most of the rivers in Soviet Central Asia take their rise in the perpetual snow and glaciers of the Pamirs. Tajikistan, the most elevated region of the Soviet Union, is called "a land at the foot of the sun".

Most of Kirghizia, another republic in Soviet Central Asia, is taken up by the Tien Shan ("celestial") mountains, one of the highest mountain systems in the world. Its most elevated point at 7,439 m above sea level is Mt. Pobeda (Victory). The landscape here consists of towering mountains alternating with deep gorges, turbulent streams, and wide valleys.

The mountains of the Caucasus stretch across three republics of the USSR: Georgia, Azerbaijan and Armenia. Some snow-clad peaks in the Greater Caucasus Range rise to more than 5,000 meters above sea level. The highest point here is Mt. Elbrus (5,642 m). The mountain slopes of the Greater Caucasus Range are covered with forests which at higher altitudes merge into alpine meadows. In the gorges below, large birds of prey soar in the bright blue sky.

The dazzling brilliance of the snow peaks, the deep gorges where turbulent mountain streams run, the slopes covered with lush southern vegetation, the valley with orchards and vineyards – these are all typical features of the natural scenery of Georgia...

Some mountains in the USSR are very ancient; erosion

has taken its toll on their gently sloping summits. Such mountains are to be found for instance, in the Urals, a range which is a veritable treasure-box of mineral resources.

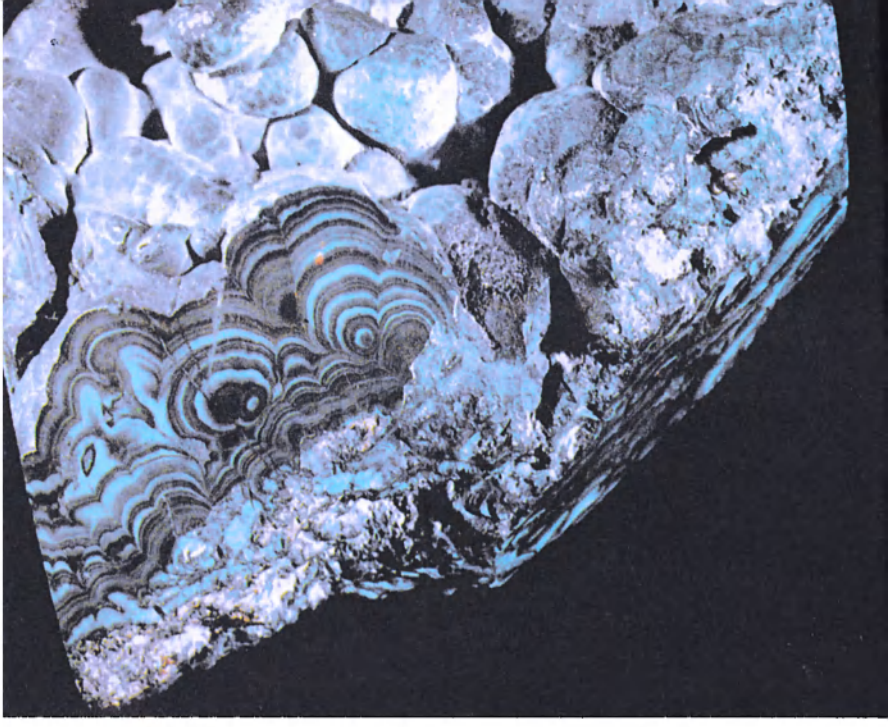
Let us now take a closer look at the mountains and discuss the sights, meetings and discoveries that await the reader there.

The Treasure-Box of the Urals

THE URAL MOUNTAINS WHICH SEPARATE SIBERIA from the European part of the USSR and which stretch longitudinally over more than two thousand kilometers have a highly varied landscape. One way to see the amazing beauty of this mountain system is by flying over the Urals from the Kara Sea to the Aral Sea. The low hills and mossy tundra of the Arctic segment of the Urals give way to the higher and craggier mountains and the coniferous forests of the subpolar section of the Urals. The much eroded mountain ranges of the Northern and Middle Urals, with their flat tops and deciduous forests, alternate with the forest-steppes and steppes of the Southern Urals. The variety and natural beauty of the Urals make this mountain country a major tourist attraction.

The Ural Mountains are about 500 million years old, which makes them about the most ancient on this planet. Once they were part of a huge mountain system which was gradually destroyed by natural forces. Hundreds of millions of years ago what is now the Ural Mountains was a Permian sea; a reminder of its existence now are vast potassium salt deposits. In their middle section the Urals are particularly rich in minerals. Over two hundred years ago, rich deposits of iron ore were found here, notably in areas near Mt. Blagodat, Mt. Vysokaya, and Mt. Magnitnaya.

The Urals have deposits of copper, alumina, gold and platinum and are particularly famous for their pre-

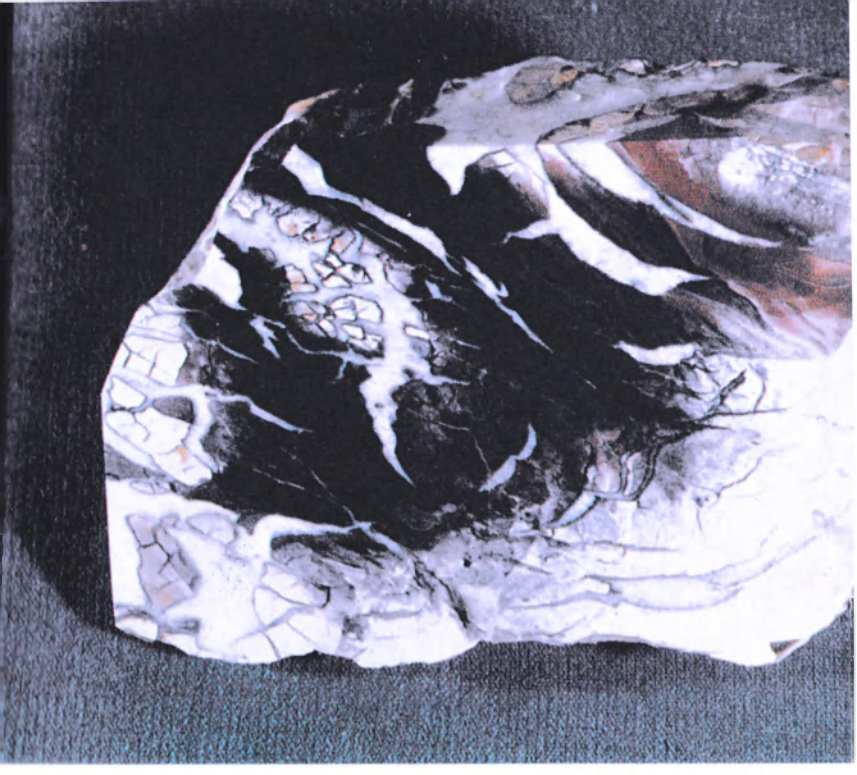


Malachite

cious stones. There is hardly a place in the world that could match the Urals for deposits of gemstones. These stones will leave no one indifferent with the pristine clarity of colour, sparkle and endless variety of their geometrical forms.

There are many different varieties of precious and semi-precious stones, but only about twenty of them have always been considered the most beautiful and valuable. Among these are: the diamond, emerald, topaz, garnet, alexandrite, carnelian, amethyst and sapphire... And all of them can be found in the Urals.

Back in Ancient Egypt emerald symbolized the beauty of nature. One cannot help admiring the bewitching dark green lustre of that stone. Pliny the Elder, a scientist in Ancient Rome, wrote about emeralds: "Indeed there



Jasper

is no stone the colour of which is more delightful to the eye."

In Russia the first rich deposit of emeralds was discovered in the Urals in the 1830s. A local peasant, Maxim Kozhevnikov, once found some large green rock crystals under the roots of a fallen tree. He decided to sell the stones in a nearby town. The stones had some cracks in them and local gemstone dealers gave Kozhevnikov just pennies for his find. However, the fact that some unusual green crystals had appeared on the market was brought to the knowledge of Yakov Kokovin, the chief craftsman of the Urals lapidary works. Kokovin asked that the stones be shown to him. When he saw them he realized that these were gemstones the likes of which had never been found in the Urals before. Without

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Smoky quartz

losing time, Kokovin took a team of workers with him and set out for the place where the stones had been discovered. That was in January 1831. Soon Kokovin and his men came upon a rich vein of high quality emeralds.

Since then the Urals' "subterranean treasury" has yielded many valuable emeralds some of which are now in the USSR Diamond Fund. One 136-carat emerald has been mounted into a brooch studded with diamonds. According to experts, this *ne plus ultra* stone is far superior to the emeralds of the Great Moghuls.

The word "corundum" means very little to the layman. Not so the names of gemstones such as the sapphire or ruby, which are also corundums, or aluminum oxides.

Agate

Depending on admixtures (chromium, iron, titanium, etc.) aluminum oxides take on different hues. The translucent corundums are known under different names, depending on their colour. The bright red glitter of the ruby and the tender blue hues of the sapphire are unsurpassable. It is remarkable that one and the same mineral is famous for different colours. The sapphire and the ruby, alongside the diamond and the emerald, are some of the most precious stones in the world.

Among the gemstones of the Urals there are many semi-precious (ornamental) stones of astonishing beauty. Agate and jasper are just two varieties of them. While being similar in general appearance, pieces of agate obtained from different places have a distinctly local

"personality" of their own. Sawn up into thin sections, agate displays a wide variety of patterns. One stone might remind the viewer of a rolling sea with leaden clouds hanging low over the water and a fishing boat on the horizon; another, of the crenellated walls of an ancient fortress with its delapidated towers and crumbling rock below.

Jasper displays an even greater diversity. This is not just a family, but a whole world of ornamental stones characterized by infinite variations in colour and pattern. Their beauty lies in original, unique tracery fashioned by nature in this material which is as hard as granite.

Jasper is a remarkable stone. A look at it evokes all kinds of associations: a rural landscape, the green banks of a river, a green meadow with an incredible conglomeration of brownish hues. A sawn-off section of this mineral might show a feathergrass steppe in a bluish haze, or birches bending in a high wind, another section may resemble a large lake with brownish banks and green waves... You can admire this natural interplay of colours for hours and never tire of it.

The best works of art fashioned out of jasper have become museum pieces. The Hermitage (Leningrad), the largest art museum of the Soviet Union, displays some of the unique stones and has a rich collection of vases, plates, inkstands and dinner and tea sets fashioned out of jasper and agate from the Altai and Ural mountains.

... There are many different kinds of precious stones in the Urals, where deposits discovered two or even three centuries ago have not yet been depleted to this day. One deposit is the Murzinsky precious stone belt between Nizhni Taghil and Rezh. Here, outside the village of Murzinka, topazes, beryls and amethysts were first found about 320 years ago. Today the precious stones obtained in these parts are displayed at many mineralogical museums of the world. Murzinka gave rise to the

art of stone cutting, polishing and engraving in this country. And this is where the first experts in the lapidary trade were trained.

Another well-known source of semi-precious stones is the Ilmen nature preserve in the Urals. This small mountaineous area stretching some forty-five kilometers north to south has some unique surface and subsurface mineral deposits. Suffice it to say that about two hundred mineral deposits have been discovered very close to the Earth's surface over an area of several hundred square kilometers.

"I have never come across anything more beautiful, although I have seen many deposits of semi-precious stones in my life," wrote Alexandre Fersman, a prominent Soviet mineralogist and a member of the USSR Academy of Sciences. "Nowhere have I been so enchanted by the wealth and beauty of nature as in the quarries of the Ilmen Mountains. I could not take my eyes away from the spoil banks of the bluish-green Amazon spar. Everything around was covered with sharp debris of this rock glistening in the sun... I could not hold back my admiration for this wealth and unwittingly recalled a somewhat incredible story that an old mineralogist once told me about an entire quarry in the Ilmen Mountains being embedded in just one crystal of Amazon spar.

"The beauty of these quarries lies not only in the bright bluish-green amazonite, but in its combination with the greyish-smoky quartz which grows through it, forming certain geometrical patterns which sometimes look like a fine ornament of ancient Hebrew characters or like large grey hieroglyphics against a greenish-blue background. These patterns in pegmatitic granite are so varied and unusual that looking at them one is tempted to try to decipher some unknown writings of nature itself. Travellers and explorers who visited these parts in the late 18th century could not find words to express their admiration. These stones were used for the making of

table tops which can be seen at the Hermitage and to this day engage the attention of modern scientists seeking explanations of natural phenomena."

The fame of the Ilmen Mountains spread far and wide, attracting hundreds and even thousands of people and inducing scientists to raise their voices in defence of this unique treasure-house of stone. However, it was only after the Great October Socialist Revolution that the priceless heritage of the people was placed under the protection of the state. In 1920, Lenin signed a decree which said: "In view of the exceptional scientific importance of the Ilmen Mountains in the Southern Urals near the Miass and for the purposes of preservation of their natural mineral wealth, the Council of People's Commissars resolves: ... some areas in the Ilmen Mountains shall be declared a state mineralogical preserve, i.e., the property of the whole nation, to be used only for accomplishing the scientific and scientific-and-technical tasks of the country."

By the time the reserve was set up, a total of eighty-two minerals had been discovered in the Ilmen Mountains. Today this figure is about two hundred, with fifty of the minerals considered very rare and six occurring only in the Ilmen region and nowhere else.

This place is unique not only for its stones. In 1936 the Ilmen Mountains were declared a nature preserve, for their animal population and vegetation are as unique and varied as their mineral wealth. Suffice it to say that in the Ilmen area alone, 815 higher plant species and about two hundred varieties of moss and lichen occur in the mountains, valleys and on the lake shores. The animal world there is just as rich: out of the 700 bird species living in the Soviet Union, 214 (about one third) are to be found in this nature preserve in the Southern Urals.

When the Earth's Surface Gives Way

THERE IS A PLACE IN THE MIDDLE URALS where people are not really surprised when the Earth collapses literally before their eyes. This area is called the Ufa Plateau. It is mostly made up of limestone which, as is known, can very easily get eroded by water and dissolved in it.

For many years a lake existed on this plateau near the town of Kungur. There was nothing remarkable about this lake which caught people's notice only after it had literally "vanished through the ground". All that was left in its place was a dark sink-hole. This occurrence is easily explained by the action of underground water.

All water on Earth goes through a hydrological cycle. It would be virtually impossible to trace its circulation in every detail, but the general principle is as follows. The sun heats up the Earth's surface, causing the evaporation of great amounts of moisture into the air. The invisible water vapours rise into the atmosphere from the surface of the oceans, seas, rivers and lakes. All plants emanate water vapours, and animals exhale them. The higher the temperature of the air, the more water vapour it may contain. At the temperature of 20 C above zero a cubic meter of air can contain 17 grammes of water vapours. If more vapours enter this already moisture-saturated air, they will condense, turning into tiny drops. At cold air temperatures such drops of water and tiny ice crystals form clouds.

Water vapour and clouds do not stay in one place but are carried to and from all parts of the world by air currents. Great amounts of moisture are carried by winds from the warm seas. The World Ocean is the main supplier of water into the atmosphere. Moving over the continents, the air masses lose this moisture in the form of rain.

Once on the Earth's surface, raindrops go different ways. Some of them get into water streams, rivers and

lakes or directly into the sea, from where they evaporate into the air again. Some of the precipitation may stay for a while in puddles or in plants, but soon, having been heated by the sun, it again sets out on a journey through the atmosphere.

Much of the precipitation seeps into the earth, percolating through a multitude of pores into the soil. It has been estimated that approximately 20 per cent of the soil is water. Much water stays in lower, deeper layers of the earth. The softer and the looser the soil, the easier it is for the rain and snow water to penetrate into it.

As they go deeper and deeper underground the separate drops form subsurface streams which subsequently reach impermeable layers of the earth (such as those made up of clay, shale, granite, etc.). When such a layer is positioned at an angle, it becomes a kind of a subsurface river bed. As the subsurface stream takes in more and more tributaries, its runoff increases in volume. Sometimes such rivers reach subsurface depressions where subterranean lakes are thus formed.

Some underground rivers are hundreds of kilometers long. It also happens that the water travels underground without ever coming up to the surface. In most cases, however, the subsurface streams pass over the impermeable layers and erupt to the surface. A spring, or a source of cold subsurface water, thus appears. There are also rivers whose course alternates between the earth's surface and the subsurface layers. Some rivers of this kind, mostly in the Urals and in the Caucasus, disappear underground several times and then invariably come up to the surface again. One of them is the River Sim, in the southern Urals. I once took a trip on this river in a boat. Suddenly the river disappeared into a mountain. We got out, crossed the mountain and again came upon the same river.

In western Georgia in the Caucasus there is a river that seems to be split into two. Before it goes underground,

the river has one name, but from the point of its re-emergence to the surface it has another name. The Chusovaya River, one of the most beautiful streams in the Perm region, takes in several tributaries which disappear from the surface and then re-emerge from underground at a different place.

It is a known fact that water taken from different sources differs in taste. Why is it so? The reason is that the water taken from different places has different substances dissolved in it. Travelling underground, water encounters different minerals, including easily soluble ones. In addition to limestone which we mentioned earlier on, these minerals also include gypsum, dolomite, and rock salt. In these, ground water often scours out large karst cavities. And it is these cavities that can cause sink-holes to appear in the ground. This is exactly what happened to a lake near the town of Kungur. Situated under the bottom of the lake was a large cavity where water had gradually eroded the underlying rock formations.

In the past such phenomena gave rise to many legends and mystical stories richly laced with fantasies of all kinds. One Russian legend associated with karst phenomena is about the town of Kitezh which sank into Lake Svetloyar. This legend originated in an area where many large underground cavities have subsequently been discovered. Many lakes are also of karst origin. This is how they appear. Over a long period of time, ground water erodes the vaults of the subsurface cavity so that the latter collapses and the sink-hole which thus appears is filled with water, forming a deep lake. This explains the disasters which occurred when whole villages suddenly sank through the ground and the hollows thus formed were then filled with water.

Sometimes quite unusual lakes form around swallow-holes. These lakes exist for a short time and then disappear. Such peripatetic lakes can really intimidate superstitious people. Actually, there is nothing inexplicable about this phenomenon either: the lakes are fed by underground

springs which change their runoff depending on the season of the year. There are many such lakes in karst rock areas.

... In the autumn of 1959, strange things started to occur in a village in the southern Urals. First, residents heard some strange noises coming from underground. These noises were particularly audible during winter nights. It seemed as if some fairy-tale spirits had come there to make their home deep underground, making all kinds of booming and rumbling noises as if they were busy emptying huge bags of potatoes. Sometimes a sharp report was heard, sounding like a cannon shot fired somewhere far away.

At first the villagers did not know what to think. The noise continued for some eighteen months, when finally the news reached geologists who found the explanation. It turned out that a subsurface stream ran under the village. At a depth of about one hundred meters, it had scoured out a large cave. From time to time, as the stream eroded the walls of the cave, rock falls occurred there, and the water dragged masses of debris across its floor. All this produced the sounds heard on the surface.

Local people also recalled in this connection that twenty years before a tractor had fallen through the ground on a farm field. The depth of the sink-hole was about fifty meters, which indicated that the field was situated on top of a cave.

The residents of Kungur call it "the town on a sieve", because the underlying gypsum layer contains lots of big and small caverns, a fact that the town planners and builders always have to keep in mind. Before starting a new building they drill some wells to see if the underlying rock will withstand the weight of the structure. Significantly, in one out of every three cases the drill hits a hollow space.

The Ice Cave

THOUSANDS OF PEOPLE COME TO THE UFA Plateau from far-off places to see at first hand its subterranean miracle, the Kungur Ice Cave.

The entrance to the famous cave overlooks the River Sylva. Folk legend has it that Yermak Timofeyevich, a 16th century explorer of Siberia, spent a winter here. The cave has about sixty grottoes linked by long narrow passage-ways, and thirty lakes which have remained here since the days of the ancient river which had once created this "subterranean palace". Today the subsurface tributaries of the rivers Sylva and Iren have links with the lakes of this cave. When these two rivers are flooded in spring the water level in the lakes also rises.

...When you enter the front grotto you see that its walls and ceilings are all covered with large crystals of ice. When lit by torchlights these crystals shine with all the colours of the rainbow, as if they were studded with some gemstones from the Urals. Hence the name – the Diamond Grotto. This emerald-and-white hall is so beautiful that you forget that you are deep inside a mountain.

At the far end of the grotto, giant stalactites are suspended from the ceiling. Rising from the floor to meet them are stalagmites. Both are products of the water, saturated with calcium carbonate, making its way into the cave. When the water gathers into drops on the ceiling, the calcium carbonate precipitates, forming deposits. This is how stalactites take shape. The different admixtures that are sometimes found in calcium carbonate can tint them orange, red or brown. And rising up from the floor of the cave are limestone pillars, stalagmites which often become linked with the stalactites above and form solid stone pillars. This process takes many hundreds of years to complete. Thus, gradually the cave begins to look like a fantastic castle from a fairy-tale.

The second grotto is called the Polar Grotto. It is

The unique Kungur ice cave is a geological preserve protected by the state

reminiscent of an arctic desert with its icy hummocks and snow fields. One of the first explorers of the Kungur Cave gave the following description of this grotto: "It is decorated with many icy figurines of such fanciful shapes that for a long time I could not take my eyes off them. The first object that caught my attention was a large perfectly-shaped icy pillar with a polished surface. This pillar and its base looked as if they had been hewn out of white marble; it had a funnel-shaped hollow at the top, and half of this cavity was filled with pure water which came, drop by drop, from the snow melting on the ceiling. In some places on the floor were icy vases whose perfect shape was fascinating. Their similarity with man-made vases was enhanced by the fact

that their cylinders were hollow and half-filled with the pure water dripping from the ceiling." The ice in the first two grottoes does not melt even in the summer.

The Dante Grotto... Here ground water has created what looks like an illustration for the inferno described by the great Italian writer, Dante. The figures of some fantastic animals seem to be frozen in movement. As you leave the cave you meet a stone monster staring at you with its fiery eye.

There are several more grottoes, called Coral, Etherial, Seabed, Sculptural, Meteorite and Formidable. Each one of them – designed and shaped by the indefatigable sculptor, nature – is inhabited by characters coming straight out of the folk tales of the Urals. You stand wonder-struck by the magnificent display of rubies and huge lumps of amber, emerald-green malachite all of them produced by the interplay of light and shadows on stones and ice.

The Kungur Cave has four tiers with the largest grottoes located on the second level from below. The lowest tier has so far remained largely unexplored because ground water is still at work there. The oldest of all is the upper storey which has long since been vacated by its "builder", water; many of the cave's vaults have collapsed. The ice cave still conceals many wonders of the subterranean world.

There are many caves along the rivers Belaya, Yuryuzan, Sim and Iset in the Urals. Every year more and more "underground palaces", each one inimitable in its own way, are being discovered here.

The scientists who explore these caves find traces of ancient human life here: remains of primitive people, stone implements and other artifacts. On cave walls, the artists of those distant times drew pictures of what they saw around them and what mattered in their lives. Speleologists have discovered a whole gallery of such

The Skazochny grotto in the Kungur Cave

drawings in the Capovaya Cave overlooking the Belaya River in the Soviet autonomous republic of Bashkiria. Pictured on the walls of the cave are a horse, rhinoceros and several mammoths. In another place an artist who lived there thousands of years ago drew on the wall a picture of what looks like two semi-humans or semi-beasts.

Some organisms endemic to such caves have also been discovered there. Almost all of these organisms are translucent because they lack pigment in their integumentary tissue: the fish are pale cream, and the beetles are light brown or yellowish.

But the most remarkable discovery of all was made quite recently by a group of tourists who found a new cave in Bashkiria. When they entered it they were astounded by the view of the stalactites and stalagmites that glowed in the dark. The group spent several days examining the cave, following which time they found that the cuts and bruises on their hands had healed up, that their head colds had disappeared, and that all of them felt refreshed and full of energy.

This is what had happened. The subsurface water which penetrated into the cave had brought atoms of radioactive carbon which caused the luminescence in the stalactites and also ionised the air, killing microbes. The caves of Bashkiria's mountains have had ample opportunity to prove their health-building effects. For instance, just four days of stay in the Capovaya Cave would be quite sufficient to cure chronic cases of malaria and sore throat.

Radioactive substances are not the only healthful agent you can find underground. Physicians have found that many ailments can successfully be treated in caves, karst grottoes, and salt mines. Apparently, the microclimate there – clean air, constant atmospheric pressure, temperature and moisture content, and the absence of disease-inducing microbes – have a good effect on patients.

Nature–the Great Sculptor

IT IS NOT ONLY UNDERGROUND THAT THE forces of nature create their masterpieces. There are many places on the Earth's surface that set us wondering about the fantastic works of this great sculptor.

One such place is a gorge in the Karatau Mountains, in Soviet Central Asia. There are dozens of various stone sculptures there. Standing on the crest of a mountain is a giant bear, looking down into the valley below, showing his utter displeasure at man's invasion of his domains. A short distance away an old man, also sculpted in stone, stands leaning against a cliff and frowning at a fantastic animal with a horse's head. Then you see a dragon with its terrifying jaws... Two fossil pangolins ... An ugly old woman... A dog as big as a house... And again some fantastic monster... Many of these stone sculptures are so expressive that it is almost unbelievable that they have not been created by man.

One "sculptor" here is the wind which works tirelessly, transforming the Earth's surface after its fancy. The wind whips up into the air masses of dust–from fields, roads, from wherever it blows over dry uncovered land. It blows the dust out of every crevice in rock formations. As a result, the cliffs sometimes take fantastic shapes. Helping the wind are heat and cold, rain and snow, plants and microorganisms.

Another "architect" is the changing temperature of the air in areas of continental climate; where it is hot at noon and cold at night. The rocks in such areas get hot in the daytime and cool off at night. These temperature fluctuations loosen the links binding the granules of which minerals are composed. The cracks thus formed are filled with water which freezes up and expands in cold weather, eroding the rocks still further. In addition to that, the water from rain and melting snow seeps into the rocks, dissolving particles of limestone, eroding the grains of feldspar and other minerals.

Stone figures sculpted by nature on Mt. Demerji in the Crimea

Some plants also contribute to the erosion process. One of them is lichen whose minute spores are transported by the wind over long distances. The spores get into cracks in the rock where they sprout; then they firmly attach themselves to the stone and gradually erode it.

It takes centuries for these natural forces to change the appearance of a cliff, a mountain range or a piece of rock. The fantasy of the great artist–nature has brought forth some unique creations: some of them huge, resembling majestic castles of olden days, others looking like fantastic animals and fearless heroes of folk legend.

Millions of years ago, the River Pechora in the northern part of the Urals took its rise among some unassailable

mountain peaks. With time, the forces of nature have changed everything there. There are no high mountains there any longer. All that is left of them are some residual rocks. These stone giants stand like soldiers holding the last line of defence in a long, fierce battle with frost, wind and water. Many of them look like animals, people or even watch-towers... There is a line of them on the top of a mountain which the local residents, the Mansi, call the Mount of Little Gods. Another Mansi legend has it that a long time ago some giant robbers were turned to stone on that mountain.

Boat trips on the Chusovaya River in the Middle Urals are very popular among tourists. A most impressive tourist attraction here is the Warriors – giant cliffs about 70 to 100 meters high towering over thick forests. In some places these cliffs squeeze up the Chusovaya so much that the river turns into a turbulent stream.

As we mentioned earlier on, the area now taken up by the Ural Mountains was once an ancient Permian Sea. When the sea receded it left thick layers of limestone which were subsequently compressed by tectonic forces into giant folds. The Warriors are silent witnesses of the gigantic volcanic catastrophes that once rocked this planet.

... If you follow the Chusovaya's meandering stream its every turn will bring you memorable sights. One is the giant stone called Pechka (the Russian for stove, or hearth). It stands on top of a dome formed by subterranean pressure which failed to break out into the open, but only raised a vast area of limestone. Seen from below, the trees growing on the upper part of this "stone" look just about the size of a pencil. Next to it lies the Cave Stone, so named because opening in its side, some thirty meters overhead, is a cave, one of many in these parts.

A few hours later the tourists taking the river trip will see still another memorable sight – some stone folds raised by the monstrous subterranean forces to as high

as 70 meters. Here, wind and water eroded and weathered the looser rock layers, forming several parallel stone corridors. The forest here looks as if it were divided by high grey walls...

Rivers of Ice

AND NOW TO GLACIERS. THERE ARE MANY of them in the Soviet Union. Here are some impressions of a person on a first visit to the Pamirs:

"Our helicopter flew over a weird chaotic conglomeration of craggy mountains clad with ice and perennial snow. The silvery peaks glistened in the sun like giant crystals of unimaginable shapes and sizes. All that looked like a magic fairy-tale created by nature itself. We saw the famous 'roof of the world' with the highest mountain peaks in the USSR. All around us were glaciers. In the Pamirs alone there are more than four thousand glaciers, taking up an area of about ten thousand square kilometers. This is a gigantic accumulator of moisture which feeds all the republics of Soviet Central Asia with water.

"Glistening in the sun, the glaciers slowly passed by underneath. Blizzards were blowing on the steep mountain slopes. Here and there tremendous avalanches could be seen pitching into deep precipices. There was not a living soul in sight. If creatures from other planets could glimpse the inimitable view of the Pamirs they would surely decide that our Earth is uninhabitable: it is difficult to imagine that life is possible in this realm of permafrost, in this desert of stone and ice."

A long time ago the first explorers of glaciers thought that the mountain ice cover was perpetual. The Buddhist monk Xuan Jiang who twelve centuries ago crossed the Tien Shan ("celestial") mountains with a caravan made a record of his impressions of this trip, which has come down to us. The endless ice, avalanches, the lifeless natural environment and the fierce wind had a frightening

effect on the superstitious travellers: "The snow which has been accumulating here since the time when the world began has now turned into huge lumps of ice which do not melt either in the spring or in the summer. The smooth infinite fields of hard and glistening ice stretch between two icy walls rising sheer to great heights on either side. The cold wind blows fiercely and the travellers often fall victim to dragons. Those following this path must never wear red clothes or shout. Those who forget this precaution will be struck by all kinds of misfortunes."

If the snow and ice in the mountains had really never melted, then over the centuries the glaciers would have grown to monstrous size. Actually, every year the glaciers are augmented by fresh snow, while the earlier accumulations lose some of their water. In the process some glaciers grow even bigger, others "lose some weight".

Mountain glaciers are essentially rivers of ice. Descending the mountain slopes and coming out upon wide and even spaces, the ice spreads over it just like a river in spate. In narrow valleys and gorges the ice moves like a mountain stream, except that this movement is often so slow as to be almost unnoticeable to the eye.

Not so long ago the glaciologists from the Kazakh Academy of Sciences examined the West Tien Shan mountains and found that nature had created there a veritable ice belt a thousand kilometers long. To date more than 900 mountain glaciers have been explored and found to contain about a hundred billion cubic meters of fresh water.

In all, some seventeen to eighteen thousand square kilometers of mountain surface in Soviet Central Asia are covered with ice. Maybe this ice will not stay there for centuries as before? Back in very ancient times, the people of the mountain areas of Tajikistan

The snow peaks of the Caucasus

knew how to expedite the melting of ice and snow in the mountains. The method was very simple. All they had to do was to cover the frozen area with earth, soot, ash or coal dust. It was also observed a long time ago that glaciers lose much of their weight when they are covered with volcanic ash. This is why volcanic eruptions are often followed by catastrophic floods.

The water trapped in the glaciers of the Tien Shan and the Pamirs is vital for the rivers in Central Asia. Stored up in the mountains in the form of ice, and bound with icy cold, this water is a valuable asset in a hot year in the dry lowlands. However, nature does not always behave in the best of ways, which means that it must be helped where it cannot cope otherwise. Today science has gone a long way towards solving this important problem. The experiments in the artificial inducement of the thawing of glaciers carried out by the Geography Institute of the Academy of Sciences of the USSR have shown that the dusting of the surface of glaciers with pulverised coal can increase the fluvial runoff by close to 50 per cent of its annual volume. The water produced by the thawing of glaciers must be used thriftily, which means that the artificial melting of ice should be applied in Central Asia only in the dry season so as to prevent depletion of the ice on the "roof of the world". The Pamir glaciers are vital for Soviet Central Asia.

The largest mountain glacier in the USSR is also in the Pamirs. It has been named after the Russian geographer Alexei Fedchenko. This enthusiastic man lived a short life, a mere twenty nine years, but he accomplished a lot. Together with his wife he explored much of Central Asia and discovered the highest mountain peak of the Trans Alai mountain range (7,134 m) which now bears Lenin's name.

The Fedchenko Glacier has the total length of seventy-seven kilometers; the thickness of ice in some places reaches 1,000 m. With its total area of 900 sq. km, the Fedchenko glacier gives rise to many Central Asian rivers.

A mountain lake

About half a century ago the world's highest altitude hydrometeorological station was set up in the Pamirs. Its base is a small house built on a steep rock some 4,000 m above sea level. The researchers who live there are on round-the-clock duty, collecting and transmitting information about the weather, and, most importantly, about the behaviour of the glacier.

The glacier, cut by numerous cracks and crevices, is slowly sliding down a wide mountain valley at the rate of 2.5 to 3 m per day. The ice melts gradually, with more snow falling on it. The meteorologists keep record of the intake and expenditure of moisture in the glacier. This operation, seemingly simple and routine, is sometimes fraught with danger.

One morning, the head of the station, Victor Tarasenko, went to the other side of the glacier to take down the readings of the recording instruments. On his way back he was caught in a violent snow storm. The hurricane wind was trying to knock him off his feet and threatening to throw Tarasenko down from the cliff or push him into a crevice. Fighting his way against the wind, Tarasenko moved closer and closer to the weather station. Short of breath, he kneeled as he tried to massage his cheeks with the prickling snow. He found it more and more difficult to breathe and decided that he needed a rest.

... So there Tarasenko lay on his side, shielding his face against the howling icy wind. He tried to get up but could not. It was not until three hours later that the head of the meteorological station got out of the snow-drift which had almost buried him alive. And there his colleagues found him.

The behaviour of glaciers is sometimes unpredictable. For instance, in the autumn of 1969, the Kolka Glacier in the Caucasus suddenly took off on a downward slide at some 100 to 200 m a day, by turns stopping and resuming its progress for about two months. Such glaciers are called pulsating glaciers.

The treacherous character of the Medvezhy (Bear) glacier in the Pamirs is also well known. Once every 11 to 14 years the glacier makes a "spurt" of 1.5 to 2 km in a matter of days. At such times the speed of its movement can increase thousand-fold. Glacial pulsation itself is not very dangerous but for the fact that, upon entering a river valley, the ice blocks it, forming a lake. The stronger the dam thus created, the greater the accumulation of water can be, and the greater the potential destructive energy it will have. Sooner or later the artificial dam bursts, letting an avalanche

A frozen waterfall in the Caucasus

of mud and water, huge boulders and pieces of ice tumble down into the valley... To prevent this, it is necessary to divert the water from the lake at the earliest possible stage.

New methods have recently been evolved to prognosticate and eliminate the dangerous consequences of shifting ice. And this means that specialists are now prepared to cope with the effects of the next offensive of the Medvezhy glacier, which is expected to take place in a matter of years.

... The modern geological epoch has been called an era of receding glaciers. In the past several years, however, research has shown that many mountain glaciers are actually advancing rather than receding. For example, the glaciers in Alaska and in the southwestern part of Canada are growing. So are the glaciers in Central Asia. Could it be that this is just a first signal of an advancing new ice age?

It is too early to make definite conclusions just yet.

Shadows in the Mountains

THIS HAPPENED IN THE TRANS ILI ALA TAU (the West Tien Shan mountains) several years ago. A small group of mountaineers were ascending one of the peaks. All the members of the group were young, except for the guide who was a highlander of advanced age. Most of them had never been to the mountains before. At first everybody moved at a brisk pace. But as they climbed higher and higher, the progress grew slower. Soon they all felt very tired - all of them but the guide who kept up the pace, jumping easily over crevices and moving agilely from one ledge to another.

The view around them was magnificent. Everywhere, as far as the eye could see, were snow-clad mountains; those closest to the climbers were dazzling in the glare of the sun, those away on the horizon looked greyish-blue.

Down below, the steep mountain sides merged into deep gorges. The thick forests which covered the lower, gently sloping parts of the mountain sides alternated with patches of light-green mountain meadows.

At about 2 p.m., when the climbers had reached an altitude of about two kilometers, a cold northerly wind started up, blotting out the sky with dark clouds. It began to drizzle.

The rain and fog which had imperceptibly stolen up on the climbers formed what seemed to be an impenetrable grey wall. The mountaineers, by now tired and soaking wet, considered whether they should abandon the climb and return to base. The guide, however, insisted that there would soon be a place where they could have a rest. In a quarter of an hour the group came upon a small old log cabin. Inside they found some dry firewood (it is customary in those parts a supply of fuel to keep in mountain retreats), and soon a fire was playing in the stove. The climbers, now in better spirits, cooked their lunch and dried their wet clothes... Two hours later, when the sun reappeared in the sky, they decided to continue the climb.

Now they were moving much slower, saving their energy, and finally reached one of the peaks on the side of the mountain. The strong northerly wind continued to drive the clouds scudding across the sky. The sun had already set low over the horizon and its rays were now shining in an upward direction. And then something quite unexpected happened.

One of the climbers had left the guide behind and was the first to reach the summit. As he stepped onto the cliff, the giant shadow of a man appeared in the east against the background of the clouds. The human figure could be seen so clearly that everybody stopped in their tracks, as if by command – everybody, that is, except for the guide who calmly looked at the giant shadow and at the awe-struck young people, and said with a chuckle:

"There is nothing to fear! These things happen." And he continued his climb.

When he reached the top of the cliff and stood next to the young man who had made it there first, the clouds reflected another human shadow of the same size as the first one. The guide took off his warm felt hat and waved it in the air. One of the shadows repeated the movement: its giant hand rose to the head, took off the hat and waved it. After that the mountaineer raised his walking stick, and the giant shadow repeated his motion.

The climbers gasped in amazement.

After that each one of them climbed the cliff to look at his own shadow in the air. But soon the clouds moved across the setting sun, and the unusual shadows disappeared...

Scientists have named this natural phenomenon the "Brocken ghost", after Mt. Brocken in Germany. It was many centuries ago that giant shadows were first seen rising now and then above this mountain. Superstitious people thought that these shadows had come from the other world, and that witches assembled on the mountain. Actually the giant "ghosts" seen there were the shadows of people who happened to be on the mountain at that time.

This is how it happens. Early in the morning, at sunrise, you climb to the mountain top. On the side of the sky opposite to the sun are clouds and fog. The sun rays illuminate the human figure, its shadow falls on the clouds, and these, like a distant huge screen, show a giant silhouette. The effect is roughly the same as when you stand in a room between a lamp and one of the walls, but closer to the lamp. Then you will see your enlarged shadow on the wall.

Obviously, mountain "ghosts" appear not only on Mt. Brocken but on any mountain peak, given certain conditions (fog, clouds and the sun). It often happens that the shadows appear surrounded with a rainbow-hued

halo. A mountaineer gave the following description of this phenomenon after visiting the Khibiny Mountains in the Kola Peninsula:

"One early morning we decided to climb a mountain peak. It was a cold day under a clear sky. The low autumnal sun gave almost no warmth. A light breeze drove white clouds in an easterly direction. At about 11:30 a.m. we approached the western slope of the mountain the other side of which was a sheer drop. And this is where we saw something astounding, a wonder of nature which none of us had ever seen.

"Right in front of us, some 2.5 or 3 kilometers away, rising high above the horizon from the deep gorge below, was a group of giants, their number being the same as ours. Each figure was a dark shadow clearly seen against the foggy background. There were no distortions, everything was as clear as a projection on a giant screen. Each one of us recognized himself in one of the giants in the clouds. The figures, about 25 meters high, were surrounded by a rainbow aura. Later, when I told other people about it, they took it with a grain of salt."

To be able to understand why luminous radiation appears around the mountain shadows, let us recall that white colour is made up of a multitude of primary colours. Seen through a glass prism, white colour is dispersed into its components. In refracting light the prism separates primary colours, making them visible. The same thing happens in the mountains where solar light is broken up into its chromatic components. This happens for the following reason. The mountain air contains a multitude of tiny drops of water or minuscule crystals of ice – this is what constitutes fog and clouds. When light passes between such droplets and crystals, the result is the same as when it passes through a prism: it breaks up into the colours of the rainbow.

This is easily illustrated by an experiment you can conduct at home. If you take a small piece of glass,

breathe at it, and then look through this glass at a burning candle, you will see a chromatic ring showing through the glass. This happens because when you breathe at the glass it gets covered with minuscule drops of water, and the light from the candle or from a lamp disperses as it passes between these droplets.

You could conduct an even simpler experiment. Just squint your eyes and look at a burning lamp, and you will see a similar rainbow-coloured ring. This is because the light in this case passes between the eyelashes as it would through narrow slits.

And if you want to see a rainbow-hued glow around your head, you need not go into the mountains. All you have to do is to get up early in the morning, before the dew has evaporated, stand with your back to the sun, and then look at your shadow in the grass.

The above simple explanation demystifies a natural phenomenon which in the past gave rise to all kinds of legends. One of them comes from the Swiss Alps. Many years ago, so the story goes, when Switzerland was occupied by foreign invaders, the people of the country rose up in a rebellion which was led by three brothers, three strong and brave men. The rebels fought courageously for the freedom and independence of their country but failed to defeat the superior enemy. The number of the insurgents was dwindling rapidly until finally came the day when only the three brothers stayed alive. They fought valiantly but were forced to retreat higher and higher into the mountains.

When they finally reached the perennial snow, the enemy gave up the chase and returned to the valley in the apparent belief that the three men driven into the mountains could not possibly do them any harm.

So the three brothers were left alone in the mountains. They preferred death in freedom to a life in slavery. Their love of freedom was so great that it finally defeated death itself! The brothers did not die, but, instead, vanished inside the mountains in anticipa-

tion of the great day when people would regain their freedom.

From time to time one of the brothers came out of the mountain and rose to its icy summit. And that was when the people in the neighbouring valleys saw his giant shadow...

It is easy to guess now that this legend is based on the natural phenomenon described above.

"Ghost-lights"

THIS IS WHAT SOVIET MOUNTAIN CLIMBERS once came across in the mountains of Kirghizia. When they reached the 3800 m mark, a bank of dark clouds rolled out from behind the mountains. Just as one of the alpinists reached the summit a mountain thunderstorm began. To the climbers' surprise the mountain peak began to glow and a bright aura appeared around it. When one of the climbers raised his gloved hand, it, too, began to emanate tongues of flame.

The other members of the group also began to glow.

"Look your hair is burning!" one of them cried out.

"But you're also aflame!"

As it turned out, all those who did not have their hats on at that moment, had their hair aglow. And when somebody took off his hat, his hair seemed to stand on end, emanating blue sparks.

And not only the hair! Sparks began to play on the ice-axes, cameras, and the metal buttons of the men's clothes, hissing loudly like a tea-kettle about to boil.

This hitherto unnamed mountain was then called Mount Electro.

When the thunderstorm was over, the luminescence disappeared. The climbers said later that during this experience they felt a tingling sensation at their fingertips and at the roots of their hair.

References to this phenomenon appear in many sources. One climber said, for example, that when he sat down

for a rest near a cliff, he felt a sudden stab of pain in his back and shoulders as if somebody was trying to drive needles into his skin. He threw off his wrap, but the pain did not abate. On the contrary, it began to spread throughout the body. He had the impression that some gnats were scurrying all over his body, biting him. The pain was getting worse and worse, and soon the stricken man felt as if his skin was covered with burns. The walking stick that he had placed against the cliff gave off a sound similar to that produced by a bumble-bee. All that continued for about five minutes.

This rather rare phenomenon, first discovered by scientists in the Middle Ages, is known popularly as St. Elmo's fire after the St. Elmo Church in Italy where such "ghost lights" were often seen.

A long time ago seafarers considered St. Elmo's fire a good omen for a ship caught in a storm. Here is an entry made by the captain of a sailing ship in the log book:

"I ordered all the sails of the ship lowered in view of an approaching storm. At that moment we saw about thirty St. Elmo's fires flickering in various places on the ship. The fire on the vane atop of the main mast was more than a foot and a half long. I sent a sailor up to take it off. When the sailor climbed to the top of the mast he shouted that the fire was hissing like a petard filled with damp gunpowder. I ordered him to take off the fire, together with the vane, and to bring them down. But as the sailor took off the vane, the fire leaped to the top of the mast where it could not be reached. The flickering flame remained there for some time, then it began to fade and soon disappeared."

One old chronicle speaks about a large detachment of Roman soldiers on a night march. A storm was brewing, and thunder could be heard rumbling in the distance. Suddenly hundreds of bluish lights flared up on the tips of the spears carried by the soldiers. It looked as if the iron spears were burning without actually being

consumed by flame. Nobody knew the origin of this phenomenon in those days, and the soldiers decided that the miraculous lights on the tips of their spears were a good omen that spelled victory.

St. Elmo's fire usually appears on metal and other pointed objects raised aloft, such as tall spires, crosses on top of churches, lightning rods, ship masts and even tree tops. The lights look very much like tongues of bluish flame, only their origin is different. One eyewitness described a St. Elmo's fire that had appeared on a church spire after a thunderstorm. It was a long narrow tongue of flame that could be seen from afar. It lingered on for a while, at times growing smaller, and then bigger again, reaching 50 centimeters in length. Then it suddenly disappeared.

The origin of such lights has long ceased to be an enigma for scientists. St. Elmo's fires are silent electric discharges in the atmosphere. Most frequently they occur during rainstorms, snow storms, and often in the mountains when a large amount of electricity is accumulated in the clouds and on earth. A common flash of lightning is accompanied by a deafening noise (thunder) and involves an instantaneous electrical discharge. But sometimes, given certain conditions, static electricity is not discharged instantaneously but is drained away, as it were. Actually, this is also a discharge, but a "silent" one. Physicists call it the corona discharge.

In such a discharge various pointed objects – spires, poles, trees, masts and the like – begin to emanate electric sparks. If these sparks are numerous and the discharge process continues for some time, we see a pale-blue glow in the form of little tongues of flame.

There is much more static electricity accumulated in the mountains than on plains. This is why St. Elmo's fire is most frequently seen in mountainous regions. It looks by turns like an even glow, like some flickering lights and even like burning torches. Sometimes St. Elmo's fire looks so much like tongues of flame that people hurry to put it out.

The "White Tigers" of the Mountain Peaks

WHEN SNOW FALLS IN THE MOUNTAINS, IT looks like soft white down, almost weightless, descending to the ground. Everything around is covered by winter's pure white pall.

Each snow-flake, retains its lacework pattern for a few moments after its contact with the earth. But as more and more snow falls, its accumulations crush the underlying snow-flakes which lose their shape and freeze together. Gradually snow layers three and more feet thick form on the steep slopes of the mountains as more snow continues to fall.

And this is when the snow-flakes undergo yet another transformation. Covered by a thick layer of snow, the earth begins to warm up. The snow-flakes lying on the ground melt, and the water vapours then rise to the upper, cooler layers of the snow cover. The snow begins to recrystallize, becoming loose and granular underneath and more packed on top. And if the wind begins to blow at that time, the pressure over the surface of the snow begins to fall, and the water vapours get sucked out of the snow cover.

The layer of snow lying on the steep side of a mountain weighs hundreds and even thousands of tons. Gradually it loses its grip on the underlying rock and can be cut loose at any moment. This happens most often on days when the temperature of the air rises sharply.

The fresh layers of dry snow which have not yet stuck to the older packed layers can start their downward slide on the least provocation, be it a slight percussion or just a noise. Sometimes even the fall of a branch or a mere echo is sufficient to upset their precarious balance. And once this balance has been disturbed, the snow begins to slide down the slope, slowly at first and then faster and faster, with its mass rapidly increasing in the process. The avalanche picks up stones and bushes,

breaks trees and wipes out houses, and then crashes down into the valley with a terrible roar. Such avalanches are accompanied by snow whirlwinds, so violent that they can tear trees out of the ground. Sometimes avalanches cut wide swaths through century-old forests while the whirlwinds that accompany them smash trees on either side of their path.

When the "white tiger" of the mountain peaks, as snow avalanches are sometimes referred to, starts its formidable descent, it looks like a giant solid lump of snow and ice stuffed with stones and trees. People who find themselves buried in an avalanche hardly even manage to dig themselves out unless somebody helps them to do so.

The shock impact produced by avalanches is great, for even a small avalanche of about 100 thousand cubic meters weighs about eighty thousand tons, whereas bigger avalanches are several times as heavy. And when this giant slides down from the mountains at the speed of 200 km per hour, it can reduce even the strongest masonry to a heap of rubble.

However, the powerful impact of avalanches is produced not only by their weight. The snow mass pushes an air wave the shock of which is even more dangerous than the shock of the avalanche itself. The air wave destroys houses and strangles people and animals.

Avalanches occur in the Caucasus, in the Urals and in the Carpathians... They also cause much trouble to the residents of the Kola Peninsula where they sometimes occur despite the fact that the mountains there are not high.

Sometimes, although not very often, encounters with avalanches do not end in tragedy. In March 1981, two young technicians from the hydrometeorological station at the Anzob Pass in Tajikistan were out on a skiing trip. Suddenly the snow under their feet began to move. A minute later the two were hurtling down in an avalanche... A helicopter was sent out in search of the

stricken men. They were found twenty-four hours later in the gorge near a shepherds' log cabin.

Once a bulldozer operator was caught in an avalanche in the Gorno-Badakhshansky region (Armenia). The mass of falling snow picked up his heavy machine like a toy and flung it 120 meters down. The road builders thought that their comrade had fallen to his death. Luckily that was not so: he emerged out of his machine bruised but otherwise safe and sound.

People have learned to combat avalanches. They build barrier dams and avalanche-breakers and set up metal or nylon nets which break the impact of the snow slide. They also plant trees on mountain slopes, cut terraces and set up fences to anchor the snow. Recently chemists have also joined in the struggle against avalanches. Avalanche-prone areas are now treated by chemicals from airplanes, which induce the ice crystals to adhere to one another. As a result, a strong snow crust develops which prevents the snow from forming an avalanche.

Another effective method of avalanche control involves the use of artillery. A gun is placed at the foot of an avalanche-prone mountain, and several shots are fired into the incipient avalanche. Raising clouds of snow, the avalanche core slides down and disintegrates without causing any damage, for it has not yet accumulated enough destructive force.

There are dozens of avalanche control stations in the USSR, including those in Siberia, the Caucasus, the Pamirs and in the Khibiny Mountains. Using high-precision instruments the specialists there conduct day-to-day observations of the snow cover and warn of avalanche danger.

Combatting avalanches is no simple matter. Before taking a decision to attack the enemy, specialists ascertain whence the greatest danger is likely to come, and where to fire an artillery shot of the right explosive force to render an incipient avalanche harmless.

Today quite a few anti-avalanche mortars and howitzers

ensure the safety of people in many mountain areas. Most people who fall prey to the "white tigers" of the peaks are mountain climbers. Every year the mountains exact a toll of human lives among people who are not sufficiently familiar with the treachery of snow avalanches. There are few lucky men who are found and rescued from the clutches of an avalanche.

Yuri Gubanov, a laboratory technician of a geophysical expedition sponsored by Moscow University, was one of them.

Together with his partner, Valery Voloshko, he was making his way to one of the most beautiful gorges in the Dombai region of the Caucasus.

A bank of thick fog had descended from the mountains into the valleys, all but covering up the traces which the mountaineers were following. Suddenly they heard a muffled noise somewhere above but failed to realize what it meant.

The noise soon grew into a muffled rumble and suddenly out of the fog came the crest of an avalanche which engulfed Gubanov within seconds. Voloshko dived for some trees nearby to take shelter, but the avalanche caught up with him. Struggling out of the snow, he looked around but could not find Gubanov anywhere. He then rushed off for help.

The chief of the rescue station, Nikolai Semyonov, alerted the mountaineers in all the nearby camps, and soon a rescue team was on its way to the site of the accident.

Upon arrival the team set up special observation posts in case of more avalanches which in those parts were a frequent occurrence. After that they began to take soundings in the area of the accident. Hours went by but no trace of Gubanov was found. The rescuers knew that a man caught in an avalanche of heavy raw snow had very little chance of survival, yet they still hoped that Gubanov was alive.

By the end of the fifth hour everybody was exhausted.

The group decided to come back at first light and continue the search.

Waclaw Ruzewski, one of the climbers, was the last one to pick up his knapsack which he had left in a snowfield. Before leaving for base Waclaw stuck the pole through the snow, just on the off chance.

"No use. One chance out of a thousand," the other told him.

"Sometimes one chance is worth a thousand", he replied.

The pole went down three feet under the snow when Ruzewski suddenly tensed up and his face changed.

"That is him! He's there."

The men quickly cleared the snow and there they found Gubanov...

The Ukrainian doctor Yuri Fruman, who was among the group, applied resuscitation. It seemed an eternity had passed before he finally announced:

"He's alive."

For the whole of the evening, through the night and well into the morning of the next day, the rescuers stayed at Gubanov's side, administering artificial respiration, massaging his heart, applying hot compresses, and rubbing him with alcohol...

This is how an avalanche victim was saved by his comrades from the clutches of death.

It was a Mudflow

A LITTLE MOUNTAIN STREAM IN A GORGE IS almost noiseless. One can spend hours admiring its transparent waters flowing around big boulders, little suspecting that this innocent-looking peaceful rivulet can within one or two minutes turn into a raging stream. A sharp rise in the water level, or a flood caused by torrential rains or the turbulent melting of snow in the mountains can turn the brook into a roaring torrent

murky with silt, sand and soil, and smashing everything in its path.

This is a mudflow, a mixture of water, mud and stones. It often occurs in India, China, Turkey and Iran, in the mountainous regions of the western coasts of North and South America. Mudflows have also caused a lot of trouble to the people of the Caucasus and Soviet Central Asia.

Some of the most intensive and powerful mudflows in the USSR occur in the Trans Ili Ala Tau range where the natural conditions – steep mountain sides, sparce protective vegetation, sloping valleys, glaciers and alpine lakes – are conducive to their formation.

What causes mudflows?

Most frequently, they are caused by torrential rains (mountaineers even have this proverb: "Before crossing a brook, look at the sky") or by the sudden thawing of snow in the mountains. Sometimes mudflows begin when an alpine lake is destroyed. A long time ago a rockfall in the Trans Ili Ala Tau Mountains formed a large lake, Issyk. Thousands of years later, the lake ceased to exist: in the summer of 1963, it was destroyed by a powerful mudflow which swept through the Zharsai Gorge.

Eyewitnesses say that a giant twelve-meter-high swell of mud crashed into the lake, raising a huge wave that shot across its entire surface, hit the stone dam and then rolled back. The first mud swell was followed by a second and then by a third. The last swell put an end to the lake's existence: the rocks that had once blocked the course of the ancient river gave way as the water rammed through them. A few hours later Lake Issyk was no more: it was drained of all water.

Three million cubic meters of detritus, mud and mutilated trees filled the bed of the defunct lake. The mudflow was precipitated by the intensive melting of snow in the Zharsai Glacier. The melt water accumulated in a depression near the edge of the glacier burst into

the gorge of the Zharsai River. Near a steep bend in the gorge the torrent was blocked by a high barrier formed by a rockfall. Then the torrent broke through the obstacle, and the mudflow rushed towards the lake.

The old residents of Alma Ata, the capital of the Soviet republic of Kazakhstan, still remember the mudflow that devastated their city back in 1921 literally inundating some of the streets there. Among the detritus brought by the torrent from the mountains were some lumps of rock as big as a house. Fifty years later Alma Ata was again in danger as the Malaya Almaatinka River had eroded the sides of the mountains nearby, creating the danger of another disaster. To ward off the catastrophe, a mudflow dam was set up by a powerful directed explosion.

Specialists believe that a solid dam is much more effective than a series of smaller dykes built upstream on a river. Thus, the mudflow barrier built on the Malaya Almaatinka is about 100 meters high and more than half a kilometer wide at the base.

It is true that such dams are expensive to build. This is why they are raised only if no other solution is practicable. Otherwise, such measures as the organisation of the warning systems, etc., are considered sufficient.

Preventive measures are also effective in combatting mudflows. For instance, by spreading coal dust or ash over some parts of the glacier and mountain snow, it is possible to regulate their melting, thus warding off mudflows. Another effective way to prevent disaster is by planting trees and shrubs in mudflow-hazardous places. And, finally, plans are afoot for using meteorological aviation to "drain" clouds, thus preventing torrential rains in areas where they are likely to cause disaster.

Danger: Landslides

CAN A WHOLE MOUNTAIN BE MOVED OFF ITS foundation? Yes, it can. Legends about moving mountains are rooted in fact, for mountain shifts, sometimes over hundreds of meters from one place to another, have occasionally occurred.

In the 19th century, the village of Fyodorovka, situated on a high bank in the middle reaches of the Volga, began to slide down towards the river. One summer night the residents, frightened, rushed out of their homes. The soil under the entire village buckled and swelled like dough. In various places, fissures appeared and then disappeared. The landslide continued for three days destroying more than seventy houses.

Superstitious people were convinced that doomsday had come. Actually, it was water that had caused the disaster. The village stood on an impervious clayey layer over which subterranean water drained into the Volga. The catastrophe was preceded by heavy rains; the soil overlying the impervious layer became saturated with water and began to slide down on the slippery clay, as it would down an icy slope.

In the Carpathian Mountains a tremendous landslide forced the residents of a village to abandon their homes. It had rained throughout the summer and autumn up in the mountains where the ground, drenched with water, swelled up in areas overlying thick layers of impervious clay, and then began to slide downhill. That night people were awakened by a loud rumble; the houses began to disintegrate. In the morning the local residents saw an almost unbelievable sight: the mountain had moved off its foundations and had split in twain. The scientists who examined the area came to the conclusion that more landslides were likely there and recommended that the village be transferred to another place.

A valley in the Caucasus

Sometimes one disaster follows another. In February 1969, a snow avalanche descended upon a small Kirghiz town. The avalanche buried the houses in snow, so that people had to get out through chimneys. A few days later another disaster struck: the side of a nearby mountain had been eroded by snow melt water so much that it split off and began to slide downwards, heralding its approach with a low, muffled rumble. A road suddenly moved and then drifted away. From somewhere above torrents of mud poured upon the village... It took a lot of time and effort to remove the consequences of the natural disaster.

In our day and age, man is no longer defenceless in the face of natural calamities and usually puts up a well-organized fight against the raging elements. This,

for example, is what happened in the Zeravshan Valley in Tajikistan in the spring of 1964.

Torrential rains had eroded the side of a large mountain overlooking the Zeravshan River. Even before that, an earthquake had created a fissure in the mountain, and the water that got into it finished the destructive process: the slope was split in twain, with one part of it collapsing into the river and blocking it with a "dam" the size of a high-rise house.

The water in the Zeravshan Valley was rising fast. By the second day after the rockfall, the water level had risen by almost ten meters. Disaster seemed imminent: if the river breached the dam it would inevitably flood the valley and the towns of Penjikent, Samarkand, and Bukhara...

The next day a Tajikistan government commission arrived at the scene of the rockfall. Other experts were flown in from Moscow, Leningrad and Alma Ata. It was decided to clear the obstruction by blowing it up and to build a bypass channel in order to drain the water.

So the battle to ward off the disaster began. One explosion followed another. Powerful excavators were busy making the bypass channel which was to serve as the new river bed for the Zeravshan. Work never stopped for a minute. It took but several days to finish the construction of the channel. The next challenging problem was how to drain all this mass of water without flooding the adjacent area: by then, eight million cubic meters of water had accumulated behind the dam created by the landslide. It was decided that if the water level in the bypass channel should rise too quickly, the banks of the channel would have to be demolished by explosions at several points along its course.

Downstream along the Zeravshan, more demolition men were posted, ready to raise obstructions so as to hold back the destructive flow of the Zeravshan water. But after days of fighting the elements, man won out.

Now a few words about what experts call "the landslide

of the century". It occurred in the Kuraminsky Range in the spurs of the Tien Shan. The first signs of the imminent danger appeared in the late 1950s. At first everything looked harmless – almost routine. The residents of Teshiktash, a mining community, noticed that something odd was happening. Someone complained that the wicket in his orchard would not close; another person said that a tea cup had fallen off the shelf at night, and a third heard the pots and pans in his rattle. It all looked like the effects of some distant earthquake. However, in the spring of 1973, the doors and windows in all homes got out of alignment, while the walls developed deep cracks...

The villagers did not know what to think of all this. As it turned out, the "enemy" had concealed himself in the mountains. A part of the northern slope of the Kuraminsky Range had split to a depth of one hundred meters and was now hanging ominously over Teshiktash.

The experts' conclusion was: "... All the indications are that a major landslide is in the making near the town of Angren on the mountain side of the left bank of the Akhangaran River. The total volume of the landslide formation is estimated at about one billion cubic meters."

The giant landslide, formed in an area of eight square kilometers, was slowly sliding into the valley over a slippery deep-lying layer of clay. The eventual consequences were now clear to everyone: the landslide would initially dam the course of the Akhangaran River, flooding Teshiktash and the Angren open-cut coal mine and putting the Angren hydroelectric power station out of action. After that the landslide would wipe off the coal miners' community with its 15,000 residents.

There are many methods of fighting landslides: they can be broken up and washed out with water excavators, fragmented into less dangerous pieces with explosives, halted by retaining walls. All that, however, can be applied only to minor landslides, those of hundreds of

thousands and even millions of cubic meters in volume. At the Kuraminsky Range, meanwhile, one billion cubic meters of rock threatened to slide into the valley.

What could be done to ward off the impending catastrophe? One thing was clear: the residents of the community had to be saved from the imminent danger. So another town was quickly built for the miners in a safe place. Simultaneously a bypass canal which was to serve as the new river bed was built. The high-voltage line was moved to a new place. Now the most difficult thing was to stop the giant landslide. A simple yet ingenious solution was finally found. It was established that the clayey layers which the giant landslip was sliding on, initially dipped towards the valley but eventually levelled off upon reaching the plain, then continued horizontally and even arched up somewhat, exactly in the area of Teshiktash. In other words, the landslide could be stopped precisely at the latter point, rather than on the slopes of the ridge.

To create a counter balance to the landslide, it was decided to build an artificial hill of some 40 to 60 million cubic meters. There was an open-cut coal mine nearby with lots of waste rock accumulated in rock dumps. So all there was to be done was to haul this rock to Teshiktash and dump it there. That was also good for the mine, because until then the gob had to be removed to areas many miles away.

Thus the battle against the largest known landslide was won. According to experts, the catastrophe has been prevented once and for all.

Mud Volcanoes

SHORTLY BEFORE NIGHTFALL SOME SHEPherds drove their flock of sheep into a bowl-shaped depression at the top of a mountain. Here they hoped to find enough water for the animals and shelter against the

cold wind. Suddenly the silence of the night was rent by a terrible roar as a fissure appeared in the ground and a huge outburst of flame engulfed the mountain top. After that a powerful torrent of black mud poured forth to finish the destruction. That happened near Baku, the capital of Azerbaijan, back in 1902. The mud eruption took the lives of several men and hundreds of animals.

The above description illustrates an eruption of a mud volcano. When scientists began to study these unusual natural phenomena, they found that there were hundreds of mud volcanoes in Azerbaijan.

In shape many of such volcanoes look very much like ordinary magmatic volcanoes with craters at the top. Their height is never more than half a kilometer from foot to peak. The sides of mud volcanoes are streaked with gullies created by torrential rains. Unlike ordinary volcanoes in eruption, mud volcanoes discharge combustible gases, water, silt and breccia rather than red-hot magma. Rain can easily wash out the dry caked mud on the sides of such volcanoes. Mud volcanoes, unlike their magmatic analogies, erupt suddenly and mostly for a short time.

In 1977, one active mud volcano, Mt. Lokbatan, fifteen kilometers from Baku (Azerbaijan), showed a flash of its quick temper. At first a rumbling noise resounded throughout the area around Lokbatan. Then came a powerful explosion, spewing forth a shaft of fire hundreds of meters up into the air and lighting up the entire area for miles around. The flames were produced by an eruption of ignited underground gases.

Mt. Lokbatan is one of the biggest mud volcanoes in the world. It ejects tremendous amounts of gas, mud and millions of tons of breccia. Most of the mud volcanoes, however, are as small as six meters high, and even lower. But even such small volcanoes are rooted deep in the underlying strata of the Earth. The products of eruption include ancient rock materials ejected from depths of some four to even five kilometers.

Underground water undoubtedly plays the principal role in the mechanism of eruption from mud volcanoes. It has been established, though, that – little known as they are – the workings of mud volcanoes are closely linked with oil- and gas-bearing formations. Actually such volcanoes can be compared to very deep wells created by nature in oil and gas fields. This means that the eruptions of mud volcanoes can pinpoint the presence of oil and gas underground at depths which man cannot reach with the drilling equipment now at his disposal.

Just like magmatic volcanoes, mud volcanoes may lie dormant for dozens and even hundreds of years. The volcano on Los Island off Cape Pirsagat in the Caspian Sea had been dormant for half a century when, suddenly, it spouted a shaft of flame one kilometer high. The eruption was accompanied by loud rumbles deep underground and by a discharge of a huge cloud of water vapour over the island. The air over and around the island was so hot that the fishermen who at the time were a kilometer away felt the heat. For its power, intensity, and the amount of discharge that eruption was among the biggest in the Baku Archipelago over the past few decades. Suffice it to say that the volcano on Los Island had spewed more than one and a half million cubic meters of subterranean mud saturated with oil.

The eruptions of submarine mud volcanoes, of which there are many on the Caspian seabed, are even more impressive. In 1953, for example, Mt. Buzovninskaya, about four kilometers north-east of the Apsheron Peninsula, erupted, ejecting so much breccia that an islet about 70 meters long was formed. The island lasted for ten days and was then washed away by waves.

There are mud vulcanoes in other parts of the Soviet Union, too. Most of them are smaller than those described above. One such volcano has emerged on Sakhalin, in the Soviet Far East. During its eruption, eyewitnesses saw lumps of earth and broken tree trunks being lifted up in the air to considerable heights. Before the eruption

was over, the volcano had covered with mud several hectares of land.

Caves, Caves and Caves

WE HAVE ALREADY TOLD YOU ABOUT SOME caves in the Urals and in Siberia. The most remarkable caves in this country, however, have been found in the Caucasus, the Crimea, and in the mountains of Soviet Central Asia.

The giant cave in Novy Afon in the Caucasus near the Black Sea is well known far outside the Soviet Union. Every day up to two thousand tourists visit this fabulous cave. Until quite recently, however, very few local people knew about this cavern; those who did called it the "bottomless pit". The first attempt to explore it was made by Givi Smyr, a young man who was only sixteen at that time. He tied himself around the waist with a clothes line, took a flashlight and descended some twenty meters underground. After that he lit a piece of paper and threw it down into the "pit". The paper did not reach the bottom. Much as he wanted to continue his exploration, Givi realized that he would not be able to do it without help from speleologists. Soon thereafter, a team of four speleologists arrived in Novy Afon and made a discovery which was nothing short of sensational: the "pit" was actually a world-class cave the beauty of which matched the famous caves in Czechoslovakia, France and the United States.

More expeditions followed. Here is what one of the speleologists wrote about the cave in Novy Afon: "What is thought to be a bottomless pit is a black sink-well with a sheer drop. I am standing at the very edge of the hole. I have on a warm sweater, a parka and an Abalakov safety belt, the kind used by mountain climbers...

"As I descend into the abyss, I break the momentum of my fall by pushing against the walls of the sink-well.

Up to two thousand tourists come to see the grottoes of the famous Novy Afon cave every day

The patch of the soft blue sky above, which seems dazzling white from here, is getting narrower and smaller with every second, and finally almost completely vanishes from view."

The lowest point of the sink-well is a stone pocket with a narrow opening in it. "The members of the group now had to crawl through the opening. Luckily, all of them were slim and could easily get through the hole and then down into the first chamber of the cave."

Scientists estimate that this subterranean precipice is at least one and a half million years old. It looks as if a river once flowed here, judging by the shape of the caverns – all extended in the same direction and resembling a giant aqueduct All that the once full and tempestuous

stream left behind is two lakes and a deep canyon.

The Novy Afon cave has seven chambers. "The most remarkable of all is the chamber called the Temple. We could not very well gauge its height, because the beam of our torchlight could not reach higher than 70 meters. The highest known subterranean cavern was previously thought to be one of the chambers of the Flint Mammoth Cave in the United States: various estimates put its height at between 60 and 90 meters. This means that the Temple Cave is a legitimate challenger for the title of being the highest cave in the world... There are two other chambers which look absolutely incredible. Covered with white tuff and hung up with garlands of glistening stalactites and with the hoar-frost of multi-coloured crystals, they bring to mind the fairy-tale about Aladdin and his magic lamp. I can't find the right words to describe the beauty of these caverns. You have to see it all with your own eyes."

It is true. All this has to be seen!

The Crimea... Here about eight thousand "subterranean palaces" have been discovered and explored. One of the best known and remarkable caverns here is the Krasnaya Cave. It has six levels, all of them linked with subterranean passages. The upper levels are dry, and the water is working away at the rock on the lower floors, running through the galleries over hundreds of meters. In some places the underground river forms cascades of waterfalls.

One of the most beautiful caves in the Crimea, called the Cave of a Thousand Heads is situated in the Chatyrdag limestone massif. Its high vaults and oddly-shaped columns rise so high that they are lost in the dark. Suspended from the ceiling are "chandeliers" of stalactites; the floor is studded with tall stalagmites the shape of which resembles candlesticks. There are several chambers of this kind, all connected with one another and rising higher and higher into the body of the mountain.

Another well-known cave which speleologists from Yalta

The Kristalnaya Cave in the Crimea

have called Visyachaya (the hanging cavern) opens on the slope of Mt. Ai-Petri. It is not easy to reach the entrance: the wind has polished off the cliffs on the mountain slope, the sides of the mountain are very steep, and the loose scree underfoot may easily drag the climber down into the precipice... Those who manage to enter the cave are in for many surprises. Many of the stalactites here have very peculiar shapes: some look like the horns of a deer, others like a bow-tie, and still others like a fishing hook... Why are they shaped like this? Most likely, this is because the canals inside the stalactites were once clogged up and the water worked its way out through their sides, giving them most fantastic forms.

Talking about the caves in the mountains of the Crimea,

we cannot help thinking of the remarkable man-made structures of the past – underground cities, castles, monasteries and settlements hewn in vertical cliffs. Now lying in ruins, many centuries ago such settlements were abuzz with activity, noisy and multi-lingual.

The size of the "cave cities" can be judged from the following examples. The cliff city of Eski-Kermen had more than 350 man-made caves: cellars and warehouses, livestock barns and burial sites, casemates and temples. Chufut-Kale near Bakhchisarai has come down to us in better shape than most other such cities. Tourists spend hours wandering in its streets, amidst the ruined walls and dog-rose thickets, and on wheel ruts imprinted deep in the limestone. Can you imagine how many centuries such settlements must have existed to leave such marks in stone?

Cave explorers sometimes come up against phenomena which can easily frighten people uninitiated in the secrets of the mountains. One speleologist described the following experience: "Once, together with another speleologist, we crawled through a narrow subterranean passage. During a rest, when we were both squeezed between floor and ceiling, I heard sharp thumping beats which made the floor shake. I called my companion's attention to this phenomenon, and asked him to lie still and listen. He was a mere five meters away from me, but did not hear anything. Finally, the enigma was solved. Incredible as it might seem, what I had heard was the heartbeat of my companion. I could feel those heavy thumps with my whole body through the floor. The floor, which was full of hollows amplified the sound of my companion's heartbeat when his chest was pressed against it. The thumping was so loud and so distinct that we could even count his pulse."

Acoustic illusions in subsurface grottoes occur rather frequently. Many speleologists say they have heard some strange music when they were underground. Sometimes this was just one note that they heard recurring at

In some caves of the Crimea the ice stays frozen until the middle of summer

regular intervals, as if somebody was practicing with his flute. Sometimes this "music" lasts for hours at a time. It is produced by the dripping water from the vaults of subterranean grottoes. Over many years the action of the water hollows out deep apertures in the limestone cave floor. As they fall into these apertures the drops of water compress the air inside which then escapes with a melodious whistling sound.

Once two hikers strayed into a cave they had never visited before and, after walking several meters inside, suddenly heard somebody talking in a dark underground corridor. They got scared and returned to their group, saying that they had heard human voices. Soon the

mystery was cleared: what they thought were people talking was the "voice" of a babbling brook.

Optical illusions underground also occur rather frequently. For instance, a hole several meters deep might sometimes seem a veritable abyss, while a small puddle might look as large as a lake. The reason is that in the dark which a torchlight cannot fully dispel, people lose the true sense of size and proportion, and everything seems to be larger than life.

Subterranean Miracles

THERE ARE MANY "CAVE HUNTERS" IN THIS country who make new discoveries every year. Back in the 1950s Prof. Nikolai Gvozdetsky of Moscow University wrote several articles about the karst regions of Central Asia. His research attracted the attention of speleologists, who found his description of the Kyrktau Plateau (in the western part of the Zeravshan Range) with its expected vertical subterranean precipices, particularly interesting.

The first to explore this region were speleologists from Kiev who had rich experience with this type of subterranean phenomena. By that time they had discovered the Optimisticheskaya Cave, the Soviet Union's longest, in the foothills of the Carpathian Mountains. The total length of that cave exceeds 140 kilometers. Then the speleologists went to Central Asia where they spent several years on the Kyrktau Plateau. Their discoveries there made the time they had worked on the plateau worthwhile.

The discovery of a cave here in 1972 was made almost as a matter of course. The speleologists were exploring the western section of the plateau with its karst swallowholes. One of the openings looked empty at first glance, for they did not see any entrance to a cavern. But their doubts were dispelled when they threw some stones into one of the holes. At first they heard rapid abrupt

This cave city of Eski-Kermen in the Crimea was built in the early 6th century

knocking as the stone struck surface after surface of an inclined passage; then several sharp knocks were heard, two to three seconds apart, which indicated the presence of vertical sink-holes.

The speleologists widened the slit so they could get in. There it was: a short inclined passage leading to a sink-hole.

That summer they explored the precipice to a depth of 270 meters. The next year they resumed their assault, pitched camp deep underground and stretched a telephone line. Even when they reached 520 m underground they found no end to the precipice. After encountering one more of the numerous obstructions caused by rockfalls the explorers returned to the surface.

It was not until two years later that the exploration

of this unique subterranean hollow was resumed. The speleologists now reached a depth of 700 meters, which was quite an achievement in itself. Once again, they had to call a halt until the next year. "...We are back on the plateau at last," wrote one of the members of the expedition. "At Samarkand we met the Tomsk group of speleologists. The two groups – one from Kiev and the other from Tomsk – are to complete the first stage of the speleological expedition code-named Kyrktau-76. We set up tents and a kitchen, and even built a cellar. The leader of the expedition hoisted the flag, and the first group started its descent.

"The narrow sharply inclined slit led to the first sinkhole. We anchored the climbing rope and, pushing off from the sides of the well, quickly descended into the void. A minute later we found ourselves on a small platform, dozens of meters underground. A few steps away we found another deep well. We had an eerie feeling as we stood at the edge of what seemed to be a bottomless and examined the vaults lit by our torchlights..."

The subterranean grottoes found by the explorers were remarkable in their splendour. Lit by the torchlights, even ordinary drops of water looked like diamonds. Then the light beam hit upon flowers formed from calcite crystals, stalactites and stalagmites, and dripstone deposits on the walls, tinted black, blue, red and pink. All that beauty made the explorers forget about their fatigue and about the dank and cold air of the cave. The first assault group was replaced by another group, and then by a third one. The speleologists set up more camps deeper underground. That year they reached a point of 1,020 meters underground.

The final assault on the Zeravshan precipice was carried out by a group of speleologists from Simferopol, Krasnoyarsk, Perm and Lvov. They reached a large lake at the bottom of the cave at the depth of 1,082 meters. There was no other passage anywhere here, except maybe under

The caves of Eski-Kermen are arranged in wide terraces hewn in cliffs

the water of the lake. That was how the deepest cave in the Soviet Union was discovered. The speleologists called it the Kiev Cave.

Four years later it still retained its title of the deepest cave, but only for the Asiatic part of the USSR, yielding first place to the Snezhnaya Cave near Lake Ritsa in the Caucasus.

The entrance to the Snezhnaya Cave – actually, the "entrance" is a giant depression the bottom of which is covered by a sheet of ice – was discovered at an altitude of about two kilometers on an arid karst plateau. A maze of inclined passages leads to a 160-meter-deep well which opens on a subterranean river. As they followed the river current, the participants in the expedition negotiated many overfalls and waterfalls. The descent

continued until they found themselves in the middle of a large subterranean lake. They had to swim to the lake shore, with all their gear and soggy clothes...

The exploration of the Snezhnaya Cave has not yet been completed. However, even at this stage scientific information of outstanding value has been obtained. Soviet speleologists have discovered and explored the deepest cave on the territory of the USSR (the lowest point of their descent was 1,370 m). The only known cave in the world deeper than that is the Jean Bernard Cave (1,535 m) in the Alps.

Mystery of the Turkmenian Mountains

SOME TIME AGO SPELEOLOGISTS DISCOVERED a remarkable cave in the spurs of the Kugitang Range in Turkmenia. There they found... But let's start from the beginning.

... There is something mysterious about this range, with its peaks reaching up towards the sky and separated by deep canyons. The Kugitang is a veritable treasure-chest of wonders which has many surprises in store for explorers.

In the late 1950s, discovered in one of its sulphur springs was a hitherto unknown tiny crustacean which was subsequently dubbed the "water mule". Discovered in a subterranean lake in the early 1980s was a tiny blind fish of the Arctic char (*Salvelinus*) genus, a species unique in the USSR. During the same period, a plateau was discovered imprinted on which were the fossilized tracks of some ancient reptiles, most likely iguanodons.

The fauna of the mountains includes the desert falcon, the bearded eagle, the almost extinct Bukhara ram and the markhor, and even – with luck – the snow leopard. Many species of the flora and fauna of the Kugitang Mountains are listed in the Red Book.

Several years ago a group of speleologists from Krasnoyarsk came to the Kugitang to explore the caves there.

Even the first few descents underground yielded some interesting results, although the great discovery came somewhat later. In one cave they came upon two sink-holes.

The leader of the expedition, Leonid Petrenko, recalls:

"We thoroughly examined the sink-holes and measured their depth. It came to 75 meters. The vertical and slightly spiral shafts looked perilous. The sharp 'spears' of stalactites, some of them as thick as a human arm and several meters long, broke at a mere touch. The dust cornices collapsed every now and then, raising brownish dust. The light of our torchlights barely pierced the darkness some two meters ahead. It took us four hours to get to the bottom of the shaft.

"Finally on solid ground, I shook off the dust, raised my eyes and stood aghast... There was a man staring at me. His left hand was pressed to his chest, his right arm raised over his head as if he was trying to shut out some bright light. His petrified yellow face was contorted with so much suffering that even the dust of the ages had failed to erase the expression of despair in the face of certain death.

"After recovering from the shock, we looked around. Just a couple of meters from the first mummy, there was another one dressed in some strange clothing made of rough skins, with shoes of the same material. It lay face down on a high cone-shaped mound of clearly artificial origin. Two steps away was the snarling mummy of a snow leopard lying on top of an markhor mummy. Further on we saw a giant fossilized snake in a glistering stone-drip.

"We were in the kingdom of the dead. Some incredible chance had let us see what the world beyond the grave looks like. The beams of our torchlights glided about noiselessly in the ashen darkness, making the stony furnishings of the cave sparkle and lighting up various quaint objects. At every step of the way we came upon remnants of clothing and other articles, and dead bodies, bodies everywhere".

The expedition members decided that they would do better if they did not touch, move or excavate any of these things until after they had been examined by archaeologists, anthropologists and zoologists.

The lower level of the cave was connected with the outside world only by two narrow vertical passages, and it was unclear how dozens of mummies could have appeared there.

There was still another "surprise" awaiting the explorers. While they were still in the cave, the speleologists felt some painful bites. Incredibly, it was the "black dust" that was biting them. When they were climbing out of the well they noticed that the "dust" was stirring, as it was full of tiny ticks.

A few months later a group of scientists specializing in various disciplines began exploratory work in the cave. In the autumn of 1984 the newspaper *Trud* carried a detailed account of this examination, filed by its special correspondents.

... The group was preparing for a descent into the cave. The first to go down were the scouts - Grigori Sorokopud and Nikolai Popov.

The descent began early in the morning. The two got into the upper level without any problems. There they examined the wells leading to the lower gallery of the cave. One well was wider and straighter than the other, although it was literally clogged with dust and stones. At the depth of seventy-five meters even a little stone falling from above can cause a rock-fall. The other well was much narrower but cleaner. It was decided that the first well would be used for lifting the objects found in the cave and the second for getting in and out of it.

The first to go in was Grigori Sorokopud. He was to go down the bigger well, to clear it of dust and detritus and lower the communication equipment.

"I've gone down the first ten meters," he said over the phone. "There are many stones and lots of dust here... Another fifteen meters. A stone falling from above has

hit me hard on the helmet... Passed thirty-five meters. There is a ledge here, now I can rest... Passed seventy-five meters. Now I'm out of the well. I've got it. I'm standing on hard ground! Actually, I'm standing on the top of a large dust heap... It looks as if it is made of bones, some horns, and something else I can't very well make out..."

"Grigori, give us the size of the cave."

"It stretches some 150 to 200 meters to one side (I can't be more exact), and about 100 meters to the other side. Its width comes about 80 meters."

"Very good. What's its height?"

"Let me see..." There was a long pause.

"What's happened, Grigori?"

A few more seconds passed before the scout spoke up again:

"I see a tremendous dome overhead. It is dark red, or rather dark purple, and on it I see something like a fresco of an old man with a long beard kneeling in Oriental fashion before an open book. His hands are raised the Moslem way for prayer. The old man is sitting on some elevation... The impression is breathtaking. The beam of my torchlight can barely reach the dome, and some details in the picture are blurred. When I turn my head, the fresco seems to come to life. In fact it gives the impression that the old man is stirring! Request your permission to climb up to the ceiling to get a closer look."

"Don't hurry, Grigori," replied Leonid Petrenko. "First we have to do what we have on our programme. I'm sending you Nikolai Popov. On your way back you will pass right under the dome, and then you'll take closer look. And now, here comes Popov."

"I hear some noise. Now I see light in the second well," reported Grigori Sorokopud. Then came Nikolai Popov's loud and cheerful voice:

"I've arrived on the ground platform. The descent was perfect!"

The scouts divided their responsibilities this way: Grigori was to survey the wells and to set up a communications post; Nikolai would reconnoitre the cave.

After a short rest Sorokopud made his first report:

"Right under the opening of the first well is a huge cone-shaped heap, something like a mound. It is about ten meters high; at base, it covers an area of about 600 sq meters. There're two more mounds under the opening of the other well. These two are smaller in size. The entire surface of the three mounds is strewn with skeletons and mummies of different animals. The mummified muzzle of a horse protrudes from the side of one hill. I would not exactly call this a sight for sore eyes: the skin drawn over the skull, with the remnants of the horse's mane, and the tremendous teeth grinning at you. Here and there I can see human bones. All the mummies discovered earlier are where they were. At the far end from where I'm standing is a tangle (I can't find any other word) of mummies. Some ten rams are lying in a heap, their legs and horns locked together. All of them are in good condition - wool, hooves and all..."

Now Nikolai Popov came in with his report:

"I've walked about much of the cave, and found several galleries. They are quite long, so I haven't tried to reach the end of any of them. In one such gallery I found a mummified snake of a fairly large size, coiled like a cable on a ship's deck. Judging by the shape of its head and by its skin folds, this is a cobra. Incidentally, I saw another snake in the wall next to the main mound. Half of its body has grown into a stalactite, the other half is in the open. It looks as if the water has been dripping on it, so that eventually it got covered with a layer of gypsum. There are many charred sticks everywhere, they look very much like the remnants of torches. There are even some animal skeletons lying far away from the wells. At some distance from the wells, I saw a large beast of prey, with fangs five

centimeters long. Also, there are remnants of some utensils everywhere. I decided not to touch anything. All the objects I have seen are covered with dust. There are many mummified small rodents. And in one small corridor that comes to a dead end – imagine that – I found the mummy of a tiny bird. Now here's some important news: I noticed a slight draft of air at one end of the cave. The draft is very weak, but it shows that maybe somewhere there is an opening, possibly filled in with stones."

Then Sorokopud took over again:

"I have counted the mummies around the big mound. Not all of them have been fully preserved, I think there should be about ten in all. I've also found some skulls, several of them whole, and some fractured. In one place, near a skull, I saw a piece of clothing protruding from the mound. Shall I dig in?"

"No, please, don't. Let's leave it until tomorrow. It's a job for the scientists."

Three hours later, after they had set up a portable steel ladder and a communications post, the scouts returned to the surface. All the members of the expedition then animatedly discussed the results of the first day of exploration. Yet none of them as much as suspected that a remarkable find would later be made at the place where Grigori Sorokopud had wanted to "dig in".

The next day, the council of the expedition decided that some speleologists would descend into the cave and stay there through the night, a task that required a thorough preparation. So the explorers got out their instruments, inflatable mattresses, candles, food rations, cameras, and flasks of green tea. The ten men had to spend almost 48 hours down in the cave. On their way there, they recalled the praying old man and cracked jokes about their "discovery". A simple explanation was found to this enigma when on their way back the scouts had a chance to examine carefully what they had thought was a fresco of an old man. Actually it was a peculiar

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pattern of snow-white gypsum crystals which had been extruded from the rock under gigantic pressure. Just like clouds in the sky assume different contours, the gypsum formed a pattern on the dark red background which looked very much like a picture. In the dim light of the torchlights it could very well have been taken for a fresco created by man.

...The scientists in the group came from academic research institutes in Leningrad and Ashkhabad. They thoroughly examined the information collected by the scouts and produced their first working hypothesis. It was very likely that the cave had for many centuries served as a kind of trap for animals and people who sought shelter in its upper level from bad weather or from pursuit. It did not take them but one step in the wrong direction to fall into the precipice out of which they could never escape.

There was much evidence in support of this hypothesis, and primarily the fact that most of the remains were found directly under the two sink-holes. As centuries passed, more and more remains accumulated there, forming whole mounds. However, certain other facts did not bear out this hypothesis. The skeletons found at the far ends of the cave and the mummies of large animals could not possibly have fallen into the "trap" via the wells. Another fact not accounted for was that many mummies and human remains had no clothing on them.

The questions that were of particular concern to the scientists were as follows: were there cliff drawings on the lower level; were there any shards of pottery there; could some of the utensils be lifted to the surface for age determination; were there any mummies or skeletons of rare or unknown animals? Since the speleologists could hardly assess the scientific value of the objects in the cave, a communication post was set up at the entrance to it. Now the scientists could be continuously available for consultation.

Thus began the second stage of the exploration of the

cave. The torchlights and candles lit up the cave changing its appearance somewhat and highlighting the dismal russet stalactites and stalagmites and numerous objects strewn about on the dark dusty floor.

Soon came the first telephone message:

"We have found a long fabric belt at the foot of a mound. The belt has decorative tassels at one end."

"Try to shake off the dust and tell the material it is made of," replied Eminjan Masimov, a researcher at the History Institute of the Academy of Sciences of the Turkmenian SSR.

"This is a carpet belt. It has lots of dust on it, and we can't very well shake it off here. Not far from where the belt was we have also found a wooden saddle sheathed in leather. No signs of metal on it."

"This is very interesting. We would like the saddle lifted out, if possible."

The list of the objects thus found was getting very impressive indeed. A metal stirrup, a slightly curved short sickle, a woolen belt made up of tassels of different colours, and some wooden objects that looked like parts of a spinning wheel.

G. Baryshnikov, a paleonthologist from Leningrad, took the microphone.

"Please get the leopard mummy ready for lifting. Try to be as careful as possible so as not to damage anything."

"Message received. There are some more objects around us..."

After some painstaking work and extensive consultations, the men below selected several animal skulls, the mummies of small beasts, and the unusual recurved horns and prepared them for lifting.

After that the men asked Masimov to come up to the telephone.

"Eminjan, there is something sticks up out of the mound trough the dust. Looks very much like an oriental gown."

"Try to clear it of the dust."

"All right... Off goes the dust... Stretching along the collar is some rough braid... No pockets... Ouch!"

"What happened?"

"I found a hand... in the gown."

"What kind of hand?"

"A mummified hand and a piece of bone up to the elbow in the left sleeve. Nothing more found here."

A hand in the sleeve? The impression was that it had been chopped off and then thrown down separately from the body. After this find the speleologists gave a thorough examination to the human remains. In a matter of minutes, they found that many mummified bodies bore unmistakable signs of violent death.

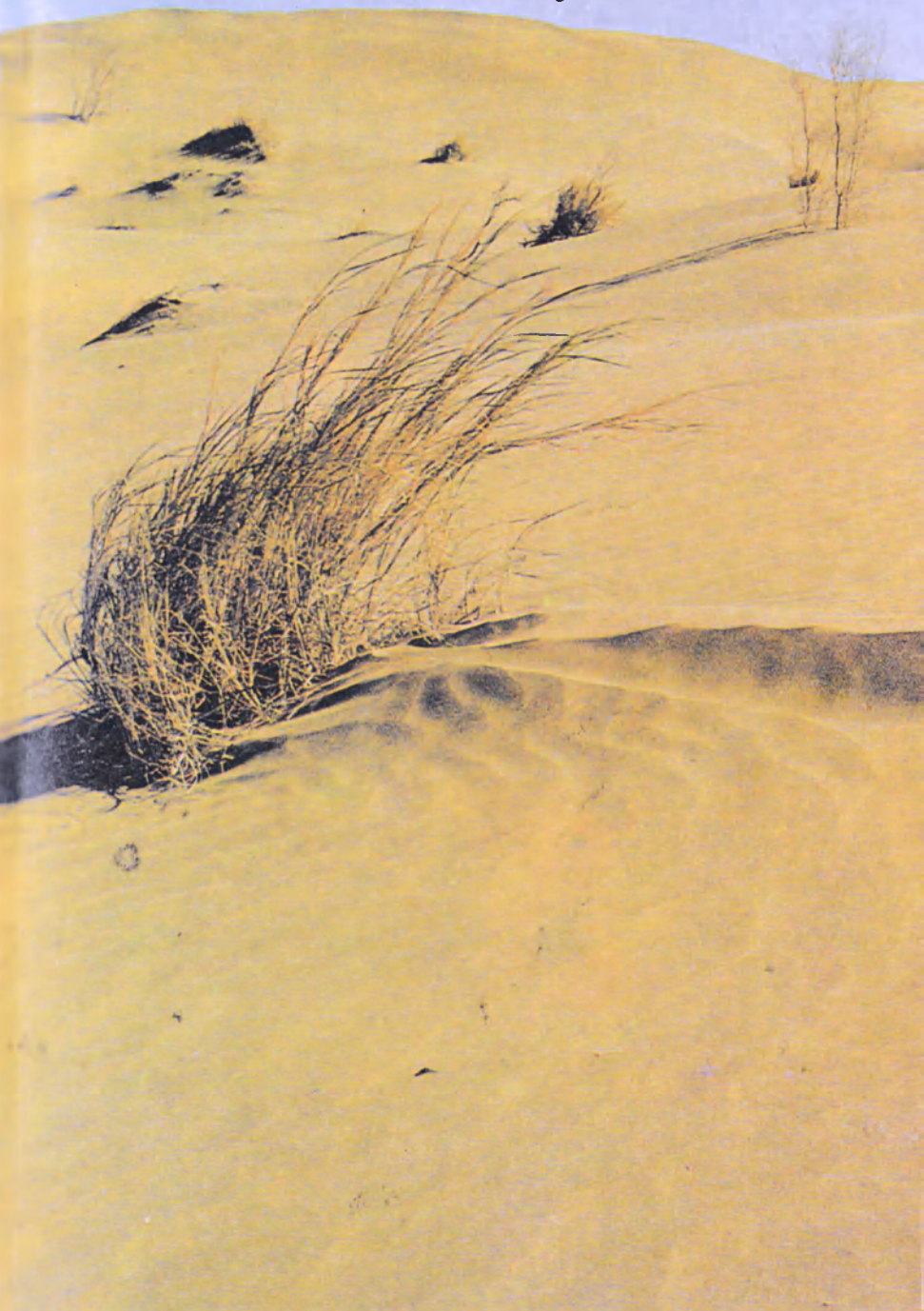
Towards evening the scientists decided to open up the mound. Thirty centimeters below its surface they came upon some more mummified human remains. It was now clear that there were not just dozens, but many hundreds of mummies in the cave.

Now some results of the exploration of the cave could be reviewed. The first working hypothesis remained valid: the cave was a gigantic trap created by nature. Other hypotheses were also advanced, one by the Turkmenian writer Hidyr Deryaev:

"I took up the history of the East a long time ago, back in the 1920s. It is not improbable that some of the finds, and especially the mummified human bodies, shed light on the practices – virtually unknown before – of the sect of the Ismailites who lived in the mountains in the 11-13th century and who fought a life-and-death struggle against their numerous enemies. The Ismailites had a custom. They used to fling their defeated enemies into canyons and collapse-holes."

... We have told you only about the first few finds in this remarkable cave whose exploration is still in its very early stages. Many new discoveries are still to come.

The Wonders of the Desert



The Soviet Union has a vast territory with forty-one climatic areas.

The flatlands of Soviet Central Asia and Kazakhstan in the south of the USSR are mostly semi-deserts and deserts. They have extreme continental climate: torrid heat in the daytime is followed by cold nights, and the very hot long summers by short and often very cold winters. There is nothing surprising about the fact that desert dwellers wear warm clothes and papakhas *(tall fur hats) all year round: in summer these clothes protect them from overheating, and in winter from wind and cold.*

In summer, the sand in the deserts is so hot in the daytime that it would take just a few minutes to bake chicken eggs in it. And in winter with its snowstorms, people seek refuge around hot stoves.

A Bit of Georgaphy

IF YOU LOOK AT THE MAP OF THE SOVIET UNION you will see that the zone of the deserts and semi-deserts begins in the Caspian Depression and stretches east across the plains of Central Asia and Kazakhstan. The largest sand deserts (there are also stony deserts and arid deserts with clay soil) in the USSR are the Kara Kum and Kyzyl Kum, which is the Turkic for "black sands" and "red sands". The landscape of these deserts is mostly comprised of *barkhans* (pyramidal sand dunes) streaked with characteristic ripple-marks. Wherever the dunes are not anchored by vegetation, they are driven from place to place by the wind.

The entire desert zone is an extremely arid area with very little precipitation: under 200 mm a year, and in some places a mere 75 mm a year. The wind blows almost constantly, causing frequent dust storms in summer and violent blizzards in winter. Even in the southernmost sector of the desert zone the air temperature in winter goes down to 30 °C below zero, and even lower. Nowhere

in the Soviet Union are the summers as hot as in the Central Asian deserts. The hottest place of all, where the average temperature in July stands above 30°C, is in the spurs of the Kopet-Dag Mountains. Nearby is an area where the highest air temperature in the USSR, 50°C, has been registered – the village of Termez on the Amu Darya River and the meteorological station Repetek. This area is the pole of heat on the territory of the Soviet Union.

The desert is attractive and even beautiful only for a very short period in spring when it is carpeted with succulent green grass and bright flowers. But after a short while the merciless sun burns out all the bright colours of living nature, leaving greyish-brown sand behind.

There are some trees growing in the desert, the saksaul being the most common: short, gnarled, its trunks and branches twisted by wind, heat and frost. The saksaul has no leaves, casts no shade and affords little protection against the blazing sun. On the other hand, the saksaul is an excellent fuel.

One of the remarkable features in the Central Asian desert is its dry forests, the *tugais* almost as impassable as the tropical jungle.

The following impression of a *tugai* was recorded by a person who got there for the first time.

"Once I decided to find a place known as the deer sand bank on the Amu Darya. This place was called so because some hoofmarks of the Bukhara deer, a rare species entered in the Red Book, had been found there. At first, I followed a footpath stretching along the high river bank grown over with *tugai* thickets, but soon the path was lost amidst crumbling lumps of earth and a thicket of bulrushes. I decided to make a shortcut and picked my way through the *tugais* stretching along the bank. The further I went, the thicker was the *tugai* growth. Soon I had to look for by-ways if I wanted to make any progress at all. I did not even notice at first that I was moving away from the

river as I got deeper into that seemingly bewitched forest. Soon I realised that I had gone too far and decided to return, although I did not know which way to go: I could not see any passage in this tangle of branches. It seemed to me that even the southern sunny sky had somehow tunned autumnal, losing its bright blue colour. Even my shoulders suddenly felt heavy as if something was bearing down on them. My hands and feet were entangled in lianas and twisted branches. I had to bend down in order to make headway, and my breathing was short and heavy. I was a captive of the *tugais*. On all sides, even from where I had just taken a step, I came up against a solid wall of intertwined crabby tree trunks and branches. Every inch of the way I had to struggle to make some kind of progress, using my hands and throwing the full weight of my body on this wall of leafless branches and then pushing in the direction where I could force a passage through the thicket.

"Somewhere behind I heard jackals howling, filling the forest with their dissonant heart-rending voices, and the cries of the Amu Darya pheasants who have the voice of the devil and the plumage of the fire-bird. What a bewitched forest! I don't think man had ever set foot on its soil. Actually he could not have done so because there was no soil here to speak of: only resilient, thick vegetation. My hands and my face were all scratched by thorns which mercilessly lacerated my unprotected skin...

"I crawled through the thicket, streaming with sweat. How great is nature and how infinitesimally small and insignificant man is in its embrace! At times I came upon small clearings with the blazing tufts of the local grass called eriactus, which is twice as tall as man. Here, I scared away some pheasants – they escaped from under the eriactus growths, making a loud noise. I could straighten

The saksaul, a highly valued plant in the Central Asian deserts

up my back and take a full breath. More hours went by. I steered my way by the light that filtered through the thick branches. That was my only guide. It was only by the end of the day that I came upon the deer sand bank, but at its other end. When I finally freed myself from the iron cobweb of branches I heaved a sign of relief. This is what the *tugai* forest is like!"

The *tugais* are inhabited by some large animals, among them wild boars, deer, jackals, and manul cats. The fauna of the sandy areas mostly comprises small rodents and reptiles. At noon, when the sun is at its hottest, even these native species of the desert and semi-desert regions do not risk staying out in the heat.

When the Wind Blows

THE VAST EXPANSES OF THE DESERTS, WITH their *barkhans*, or sand dunes, look like a jelled up sea with yellow waves. The long endless rows of *barkhans* stretch across the desert. Some of them rising 100 to 150 m tall. The sand dunes of the desert are almost constantly in a state of flux. There, sending its first puff of hot air, the wind begins to blow, bringing astir the frozen waves of the sea of sand. The tops of the hills begin to "smoke" a little, as more and more sand rises into the air with the rising wind. Any object, even a tiny one – a stone, some shrubs – holds up the sand, and sand hills are built up in the shape of a semi-circle. But as soon as the sand dune rises above the obstruction, it proceeds onwards. From the crest of the *barkhan* it collapses on the lee side of the hill with a typical noise, while more and more grains of sand are blown to the top, giving rise to another *barkhan* ridge.

There have been many cases in the history of man when the moving sands blocked rivers, buried towns, or when whole nations in Asia were forced by the wind to abandon

A salt lake near Bukhara with outcrops of rock salt on the banks

their lands. Travellers and explorers have at different times found many such abandoned oases.

It takes archaeologists a lot of time, energy and expertise to uncover the ruins of ancient settlements and to determine by them what nation lived here and when, and if it has left any ancestors.

For about two decades now Soviet archaeologists have been excavating the site of an ancient town in the southern part of the Kara Kum in the spurs of the Kopet-Dag Mountains. The ruins of the town of Altyn-Depe (the golden hill) have yielded much information about a very ancient civilization of Central Asia which existed in the south of Turkmenia some four to six thousand years ago.

Now, after many years of hard work archaeologists have brought Altyn-Depe back from oblivion. On and around

the hill, as far as the eye can reach, stand the structures of an ancient town. And although this is a dead city, what the scientists saw enabled them to reconstruct the life of its residents in some detail. This is what the head of the excavation project, Prof. V. Masson, said:

"In the northern section of the city we uncovered large blocks of houses. Four thousand years ago they were occupied mostly by craftsmen, including potters who turned out excellent tableware. We found twenty-eight different pottery models of various shapes. Later we uncovered the homes of the common folk who lived in crowded large houses of many rooms, like bees in a hive. The content of their common burial sites was very poor indeed, only a few clay vessels. The center of the city was taken up by the homes of the nobility. Those were large rectangular houses with a very elaborate layout. The burials of the rich contained numerous artifacts of silver and gold, and beads made of precious and semi-precious stones. We have also found magnificent bronze and silver seals showing fantastic animals.

"Judging by the size of the city, by the complexity of its life which was gradually opening up to us, we concluded that it might also have a temple of worship. There had to be a place from where the priests directed various farming operations, watched the movement of celestial bodies across the sky, and set the time for field irrigation. It took us many years to find such a temple. Its centerpiece was a four-tiered tower obviously modeled after Mesopotamian structures. Behind the temple were several sepulchres of priests, the house of the head priest and numerous storage pits. All this complex was dedicated to the god of the Moon. Also here we found a gold artifact - a bovine head with a moon on its forehead.

"Altyn-Depe was a genuine city, one of those which in the past were the centers of human development and where civilisation originated."

In our day and age sand no longer buries cities, because man has learned how to fight its advance.

This is an uphill struggle which is not always successful, as illustrated by the advancing sands of the Sahara. This huge North African desert is constantly expanding. Scientists who explore the Sahara's boundary areas often find traces of human activity around sand-filled river beds. Desertification poses a threat to many African states, claiming more and more fertile land every year.

The deserts in Australia and in California are also expanding. In some places the deserts of Central Asia are also advancing upon settled areas. Only well-coordinated measures taken on a nationwide scale can stop the migrating sands. More about this below.

"These Songs Bode No Good..."

THE FORCE OF THE WIND BLOWING IN THE desert, as elsewhere, varies from time to time. A light cool breeze on a hot day is always very pleasant. But we cannot say the same about a wind hundreds of times as strong.

In one of his works the historian Herodotus who lived in Ancient Greece described the Egyptian campaign undertaken by the Persian King Cambyses. An army of fifteen thousand men was on the march from Thebes in the direction of the Siva oasis. The troops' progress was slow: all around them, as far as the eye could see, were the sand dunes of the Libyan desert. Seven days later the Persians reached the Harg oasis and... vanished. Fifteen thousand men, all of them!

What could have happened?

Herodotus gives his explanation. King Cambyses' warriors were wiped out by a violent sand storm.

The Russian explorer Alexei Yeliseyev described one such sand storm in the last century:

"At about noon we betook ourselves to our tent, where we suffered through the endless noonday heat. Suddenly we heard some bewitching sounds, rather high-pitched, melodious, and harmonious, but with strong

metallic overtones. They seemed to be coming from all directions as if produced by some invisible ghosts of the desert. I shuddered and began to look around. The desert was quiet, but the sounds were wafted through the hot air and then disappeared somewhere underground.

"'These songs bode no good,' said our guide. 'The sands are singing, calling for the wind, and for death.'

"Some of the sounds were somehow cheery, others plaintive. Sharp and screechy noises alternated with tender and melodious ones. Whatever they were, they sounded more like those produced by a living being rather than by the lifeless desert. No ancient myths could describe anything that would be more incredible and at the same time more enchanting...

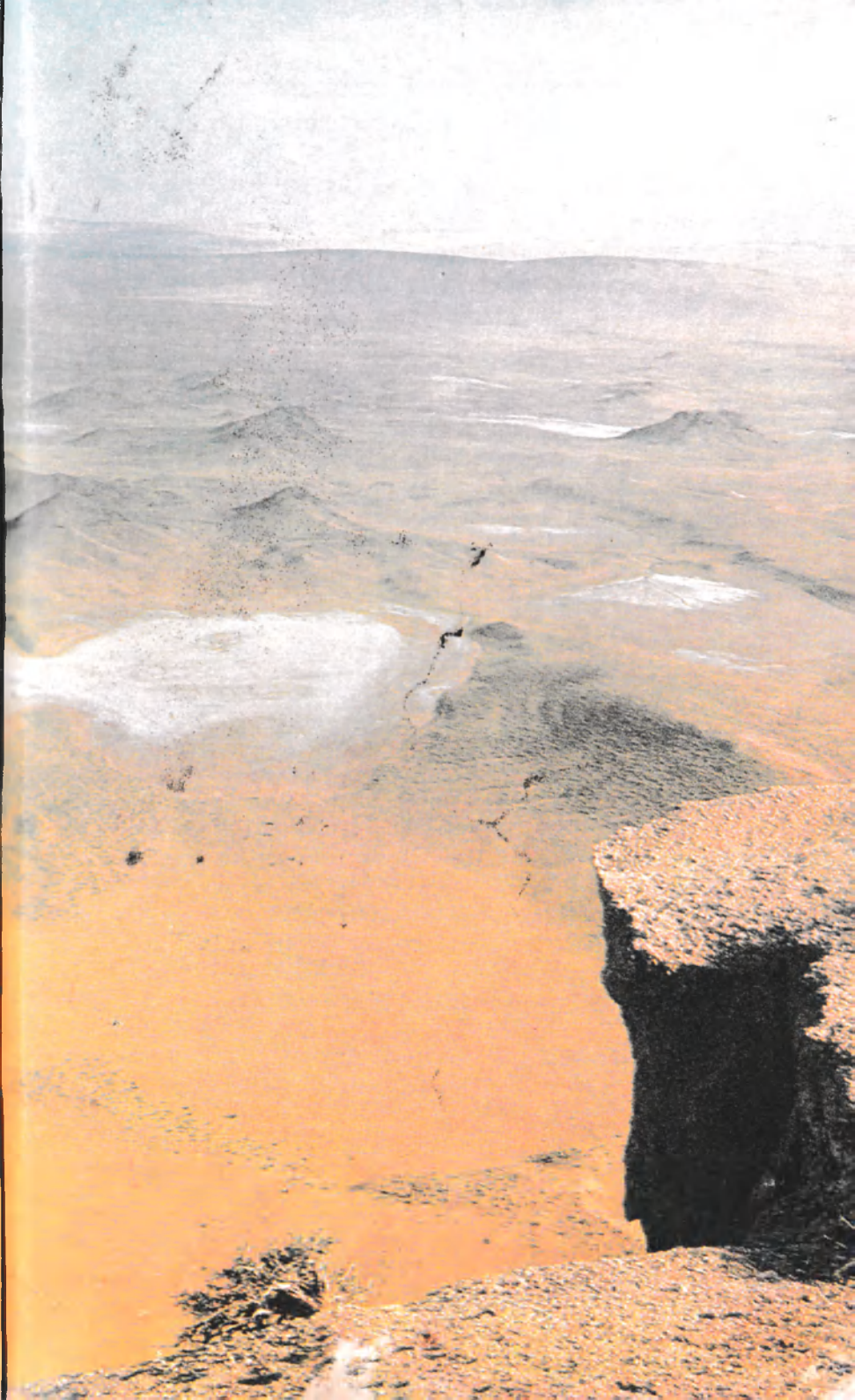
"I left the tent to survey the place from where this mysterious song of the desert was coming. The desert was suddenly quiet, for the sounds had stopped as suddenly as they had begun. But the incandescent air brought the premonition of something unimaginable and terrible...

"The giant *barkhan* in front of us was perfectly still and looked dead, but the sand at the top had already come to life, picked up by a hot whirling air current. Soon small clouds of sand appeared over other *barkhans* as well; the sky on the horizon grew dark and murky as it seemed to be descending towards the Earth.

"'These songs bode no good,' the guide said again. 'The ghosts of the sand are angry. I think it's time we set up the tents!'

"In a few minutes clouds of dust and sand blotted out the sun. I found it impossible to take a full breath. Both animals and people were choking with dust. The russet-brown twilight suddenly descended upon the desert, and the fiery wind, the *simoom* lashed out with all its fury.

Typical landscape of the Central Asian deserts



"The people pulled their sand-wraps over their heads and clung to the ground and to the camels. The dust clogged my ears, mouth, nose and eyes. The temperature of the air rose to 50°C. It was so hot that many of us fainted..."

The word "simoom" is the Arabic for "poisoning". This wind has been known for its evil deeds since ancient times. The simoom ravaged whole caravans, and it is fair to assume that it also took the lives of Cambyses' soldiers.

A few years ago an expedition of Egyptologists discovered in the sands near the Harg oasis many human skeletons and thousands of clay pitchers. According to specialists, the finds were at least two thousand years old, and the pitchers differed from those that the Egyptians and Arabs used to make. All that gives grounds to believe that the place where Cambyses had lost his army has finally been found.

Sand storms are dangerous, although this danger is usually exaggerated. The torrid wind desiccates and burns the skin, and causes insufferable thirst. The fine dust clogs up the nose and mouth, which may lead to suffocation.

In our day and age, when motorways cut through the desert, and when airplanes fly over its vast expanses, it is not nearly as dangerous as before to travel along caravan routes. However, ever now an encounter with a sand storm in the desert bodes nothing good.

As a rule, sandstorms are brought about by atmospheric cyclons formed over large areas of desert. Another cause is the heating of the sand during the hot season. When the temperature of the sand rises to 70°C and even 80°C, the air near the surface also heats up and quickly rises higher above the ground. Its place near the surface is just as rapidly taken by masses of colder and denser air. Thus local cyclons and sandstorms originate. Such winds often blow in the Balkhan corridor (the Turkmen SSR) which stretches to the Caspian Sea

between the Kopet-Dag Mountains and the Great Balkhan Mountains.

In the spring, when the atmospheric pressure drops over the sun-heated desert, masses of cold air pour here from the Caspian Sea, raising violent storms in the narrow Balkhan corridor, squeezed in between mountains.

In the autumn the situation reverses: the Caspian Sea retains the warmth accumulated during the summer, so that currents of cold air stream to the sea from the desert, where the sand has long since cooled off.

Sometimes the speed of hurricane winds in the desert can exceed thirty meters per second. The storm raises masses of sand flying at tremendous speed and carries it over the land surface.

Sand flurries are unusual and by no means innocuous natural phenomena which sometimes reach dangerous proportions. Heated by the incandescent sand, the hot air streams upward with force. The cooler air of the adjacent regions forms vortices which, as they spiral upward, drag lots of sand into the air.

Gradually the column of upswept sand grows bigger and bigger and then noisily sweeps across the desert. Sometimes several tornadoes follow one another, circling around the desert for hours, clashing, breaking apart and then rising again.

Music of the Sand

THE SAND DUNES STRETCHED ON ALL SIDES AS far as the eye could reach. The sun had just set behind the horizon, the wind started up, and then all of a sudden a strange melody was heard, as if coming from underground. The melody – the music of the sand – softened when the wind abated, and sounded louder as the wind blew stronger.

There is a sand dune in the valley of the River Ili in Kazakhstan. It is popularly known as the singing

barkhan. Of course, its melody is not very musical, but its voice is so strong that it can be heard several kilometers away. The barkhan is very large, about 150 meters high. It is made up of clean yellow sand. People who have been to these parts say that when, on a windless day, they got to the top of the barkhan and then ran down the slope, they heard a loud noise resembling the drone of a flying aircraft. One visitor relates:

"We rushed headlong downhill together with a rolling avalanche of sand. The barkhan droned and shook to the beat of its own strange music. Driven along by the sand and slapping and pushing off from it with our hands, we went faster and faster down the mountain which by then was shaking more and more violently, its roar growing louder every second."

When the wind starts up, the tiny grains of sand blown off the summit of the barkhan also begin to sing. On windless and rainy days the sand is silent.

Singing sands occur on sea coasts, on sand bars and in deserts in many parts of the world. When you walk through such sands you hear amazing sounds which resemble, by turns, the barking of a dog, or the ringing of a taut string. Some sand hills weep and groan. But all that is not nearly as impressive as the singing of sand in the desert. When the wind blows hard, the sand begins to "sing" over large areas. At times one has the impression that the whole desert is singing.

In the past this phenomenon gave rise to all kinds of stories. According to one such legend, for instance, the mysterious sounds come from the bells of some ancient cities buried in the sand. Others speak about some evil spirits held captive deep underground.

What makes sand "sing"? Some scientists think that the sound comes from the friction of grains of sand against one another. Others hold that the "singing" comes from the movement of the air through tiny

spaces between sand specks. When a barkhan collapses, these spaces become wider and then smaller, and the air is thus alternately sucked in and then squeezed out, causing acoustic vibrations.

There is still another interpretation: static electricity. Friction in the sand induces in its tiny grains electric charges, creating forces of attraction between the sand specks and thus causing them to "sing". Soviet physicist Ya. V. Ryzhko succeeded in making sand produce sounds.

He took ordinary fluvial (river) sand, dried it and cleaned it of dust and other impurities, and then charged it with electricity. When he pressed the sand with his hand, the specks produced squeaking sounds.

"There are many hypotheses about what makes sand produce such noises," writes Prof. P. I. Marikovsky. "However, all of them attempt to explain the origin of the squeaking noise but not the rumbling noise which it produces. I would venture the following hypothesis concerning the origin of the latter noise which very much resembles the roar of a jet plane.

"The thing is that any barkhan contains a layer of packed moist sand lying close to its surface. In the spring, after rain, and also in the autumn, this layer is linked with the top layer which is just as moist, and this is when the barkhan is mute. In summer, however, the top layer dries up in hot air, leaving the underlying sand moist, because of the condensation of moisture from the air. This moist layer overlies the dry sand of which the rest of the barkhan is formed. When a sand avalanche tumbles down the barkhan the upper layers descend faster, owing to the fact that they encounter less friction than the underlying layers, forming well pronounced characteristic undulations on the surface. Its uneven vibrations are transmitted to the layers of moist sand, and the latter, like the sounding board of a piano, begins to vibrate, emanating a peculiar rumbling noise."

Incidentally, when such sand is brought to a laboratory for examination, it makes no sound, but when placed in an air-tight vessel, it begins to "sing" again. Why does it happen? So far no one has given a definitive answer to this question.

Dust in the Air

WHEN THE WIND STARTS UP IN THE CENTRAL Asian deserts, the waves of the sandy sea come to life, sending clouds of dust up into the air. As the wind blows harder, it lifts more and more sand. The heavier particles settle down right here in the desert, while the finer dust particles are carried over great distances. During violent sand storms, in a matter of days the wind moves many millions of tons of dust in this way.

When the seafarers of the ancient world came back home from their distant travels, they spoke with superstitious fear about the "sea of darkness" around the Canary Islands in the Atlantic. "The sun never rises in that kingdom of eternal night," they told their fellow countrymen. Some of those who listened to these stories believed every word of it, others took them with a grain of salt. Eternal night? How could it be? Yet it frequently happens that strong winds carry so much dust from the deserts that they can literally turn day into night. In 1962, for example, a dust storm caused by gale winds in the Arabian Desert forced the traffic through the Suez Canal to close down for several days. It was so dark that people could not see the tips of their fingers when they stretched out their hands.

The residents of Ashkhabad will long remember what happened in January 1968. Air currents brought masses of dust-laden air from Afghanistan and Iran. On the morning of January 16, a black storm hit the city, plunging it into darkness.

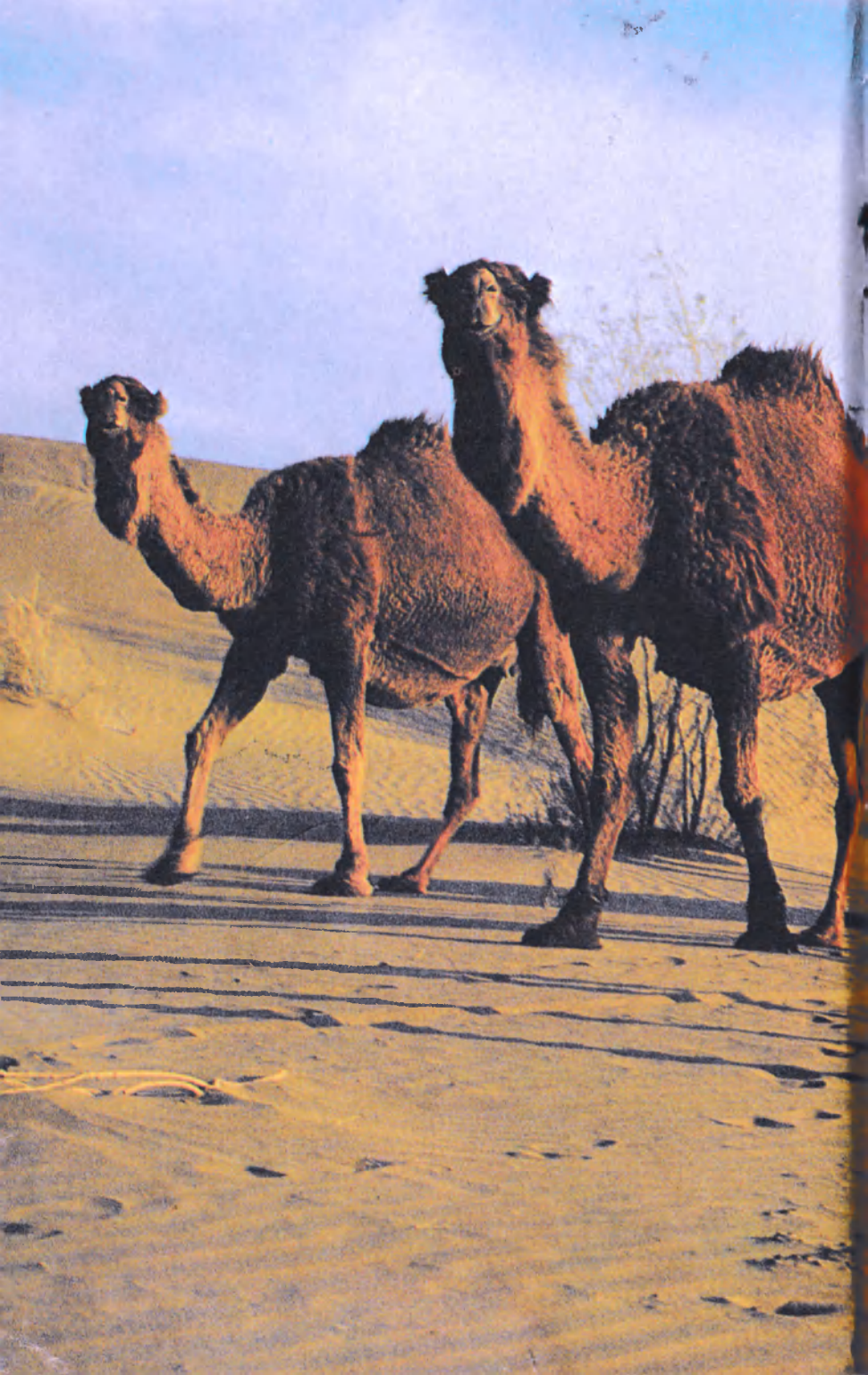
The condition of the atmosphere was highly unusual: everything around was billowing and Ashkhabad was

A giant lizard

plunged into a dark haze. Violent gusts of wind felled trees and tore off rooftops. At times, when the storm abated, people could hear the dust settle with a rustle. It was calculated that an average of 12 tons of dust settled on each acre of territory that day.

The wind can raise the dust to as high as the stratosphere, and even higher. And this is where its movement could be observed from outer space. Such observations have pinpointed the areas of the world where dust emanates into the atmosphere most intensively. In the Soviet Union these are regions adjacent to the coasts of the Caspian Sea and the Aral Sea. In the area of the Aral Sea alone

These denizens of the desert can go without water for many days



the wind transports about 75 million tons of atmospheric dust in some years...

The southern and south-eastern regions of the USSR are often subject to hot dry easterly and south-easterly winds that are often accompanied by dust storms. The haze that these winds kick up is so dark that it literally blots out the sun. This is how the Soviet writer Alexei Tolstoy described an approaching dust storm. "A yellow haze was hanging over the hills on the east. Somehow it did not look either like smoke or dust. Father said: 'That dust is from Asia.' I was scared. From that day on, my mother and father spent much time standing on the balcony, watching the approaching dark haze which was growing thicker and thicker and soon covered half the sky. It was getting more and more difficult to breathe. The sun seemed to reach the zenith in next to no time; it looked like a ball of red molten metal. The grass and crops were wilting fast, and deep cracks were forming in the ground. The water in the wells had an unpleasant brackish taste, and the nearby hills developed a white crust of salt. All the things around me when I played as a boy – the trees, the thickets of nettles and burdocks, puddles with tadpoles in them, and the cool shady pond – were now being consumed by dry hot wind."

The main sources of humidity in the Black Sea region, in the North Caucasus and in the lower reaches of the Volga are the air masses coming from the Atlantic and the Black Sea. In some years, however, the moisture-laden winds from the Black Sea give way to the dry hot winds from the steppes near the Caspian Sea and from the Central Asian deserts. These winds cause drought wherever they blow.

The sweltering heat seems to have burnt away the air itself. The hot dry wind brings neither rain nor cool. It desiccates the land, and, upon reaching deforested areas or ploughed-up fields, turns into what is known as a black storm. Such storms are particularly frequent

in the spring when the new vegetation has not yet sprouted. The bright sunshine turns into twilight, the scalding wind hits the ploughed-up loose soil, and carries much of it away.

The residents of the southern regions of Russia long remembered the raging black storm that swept across the steppes in the spring of 1892. The dust raised by the wind in the Ukraine was transported as far as Poland, Germany, Finland and even Sweden. In some of these countries the dust settled down together with rain.

In 1960, a dust storm raged for two weeks over a vast territory – from Moldavia to Turkmenia. On some days its speed reached 25 to 28 meters per second. That was a veritable hurricane that buried whole villages in fine dust. In some places in the Zaporozhye Region and the Kherson Region some villages were buried in dust up to the rooftops.

...Black storms are the scourge of many agricultural areas. They are particularly frequent in the United States, Canada, and Australia. By blowing the fertile top soil off the farm lands, the wind depletes them. The hard particles of the dust driven by the wind attack and kill all seedlings. Flying at tremendous speed, the dust can easily shatter the plants.

The Soviet Union is taking vigorous measures to combat the effects of hot dry wind on its territory. An important part in this fight is played by afforestation belts which preserve and accumulate moisture in the fields and afford good protection against black storms. On encountering trees, the dry wind absorbs moisture from their leaves and also loses some of its ravaging force.

In 1960, when the black storm was at its fierest, people noticed that wherever the easterly wind encountered afforestation belts, the winter crops weathered the storm practically unscathed. Significantly, the forest plantations here took up a mere 5 per cent of the total farming area.

Dry winds and black storms can also be combatted by retaining moisture in the fields, by improving soil cultivation methods, by planting drought-resistant crops, by irrigation and sprinkling. All these measures are being taken in the conditions of the socialist mode of economy on a very large scale.

Scientists are also working on new methods of combatting wind erosion. In Estonia, for instance, they have developed chemical method which involves the spraying of shale resin over the top soil. Experiments have shown that this method makes ploughed-up soil completely resistant to winds blowing at 15 to 20 meters per second. The resin creates a film on the soil and thus prevents evaporation. It is not only completely harmless to the vital functions of the microorganisms in the soil and to the farm crops but, in fact, increases the yield.

Man Conquers the Desert

AS WE SAID EARLIER IN THIS ACCOUNT, DEserts are expanding in many regions of the world, threatening farm lands and people. The area of the Sahara, for example, has doubled over what it was in antiquity. The Sahara advances at the rate of one to three meters per year upon the fertile land along the five thousand kilometers of its perimeter. In varying degrees, the migrating sands pose a grave threat to many states. The total area of deserts in the world now adds up to twenty million square kilometers.

What are the contributing factors behind this advance of desert sands? The first factor is, undoubtedly, the general warming up of the climate of our planet. But the main culprits are people, their barbarous and irrational treatment of the natural environment, which disrupts its ecological balance. A sad example of this is the tragedy of the countries of the Sahel which have, over the past several years, suffered from devastating droughts. The expansion of the perimeter of the Sahara results from

the predatory exploitation of the Sahel by the European colonialists. Today the struggle against the advancing desert has become a major social problem in these countries. It is clear that the desert cannot be stopped by any one of these states acting on its own.

In the USSR the struggle against the shifting sands is carried out on a nationwide scale. The magnitude of this problem should be judged against the fact that 14 per cent of the territory of the Soviet Union are drylands and deserts. The Soviet government allocates vast sums of money to cope with this problem. In Tajikistan, Kazakhstan, Turkmenia and Kalmykia tens of thousands of people are working to put deserts to productive use and to prevent the shifting sands of the barkhans from engulfing the cultivated areas. Giant irrigation facilities, new cities and townships, motorways and high-voltage lines have been built.

Problems of desertification are studied at the Desert Institute of the Academy of Sciences of the USSR, in Ashkhabad, capital of the Turkmen SSR. A priority task of its researchers is to find new effective methods of combatting shifting sands. The results of their work can be tested in the Kara Kum Desert which starts right outside the city limits.

Soviet scientists have developed many methods of anchoring sands. The barkhans are planted with drought-resistant plants, are impregnated with viscous chemicals and are shielded against the wind with screens. In the south-western part of Turkmenia alone, the barkhans have been anchored in an area of 20,000 hectares (50,000 acres).

More and more afforestation belts are being created around cities and towns, and around the farm lands which used to be part of the desert. Over the past several years alone the area of afforestation belts in the Central Asian republics has grown by a total of one million hectares.

Today, in the 1980s, the Central Asian deserts are not what they were in the past. If you take a helicopter

The fruits of the

trip across the desert here, you will see at first vast sunscorched expanses covered with sand dunes as far as the eye can reach. But after flying some 20 to 30 minutes you will see more and more green squares of farm plantations on both your right and left. After a while you will notice how these yet small islands of life overlap the sands of the desert. The helicopter goes down and you will see trees planted at different times: some of them are yet fighting for a place under the sun, and others are tall and strong, able to stand up to the deadly onslaught of the nearby barkhans. A short distance away is a tall shady forest. The saksaul – the "king of the desert" – feels very much at home here. Other trees – oaks and pines, acacias and planes, apple and walnut trees – seem to be doing very well, too.

desert transformed

The researchers at the Desert Institute in Ashkhabad once conducted this experiment: they planted maize seeds and began to water them with a sprinkler. Soon the experimental plot was covered with seedlings. A month later the maize grew up to its full size – as tall as a man. Of course, the biologists used fertilisers and irrigation (in regimented quantities and at fixed hours of the day). This was necessary in order to prevent underground water from rising and salinating (or swamping) the fertile top soil.

The maize was followed by other farm crops. The experimental plots yielded impressive harvests of green mass: sorgum – 900 centners, maize – 600 centners, and alphalpha – 500 centners per hectare.

Land cultivation (and hence sand fixation) in the desert

is yet in its early stage. However, even now its first results are very encouraging. Agajan Babayev, President of the Academy of Sciences of the Turkmen SSR, says that he is "profoundly convinced that maize growing in the desert is commercially viable, because a hectare of sand is much cheaper to cultivate than irrigated soil, and also because it needs only half as much water which is valued so highly in Turkmenia. Most importantly, the planting of maize in the sand will make it possible to use more of the available fertile land for planting more valuable crops."

Economists estimate that every million of hectares of irrigated desert "virgin land" can annually yield 1.5 million tons of cotton, 500,000 tons of rice, 350,000 tons of maize. Significantly, the funds invested in such projects can be recouped within three or four years.

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Our tour of the Soviet Union has come to an end. Yet it has been only a short introduction to this country, considering its tremendous size.

But if after reading this book you decide to learn more about the USSR and get a detailed picture of its natural environment, the author will be only too happy to know that his book played a part in this rewarding endeavour.

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Vladimir Mezentsev is a man of many gifts and great versatility. In his younger years he worked with prospecting parties, taught chemistry and English, engaged in research and was TASS correspondent in the Urals and Siberia. During the Second World War he fought at Stalingrad.

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